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The Outlook

British Aircraft in Libya

ALL the Army reports since the great battle started in the Libyan desert have paid generous, but obviously well-deserved, tribute to the work of the Empire Air Forces during the struggle. Their shell guns have knocked out a number of the lighter enemy tanks, but in the main their efforts have been devoted to attacking the enemy's supply columns. These attacks have been most effective, and when one reads, as one has recently read, of 37 abandoned enemy tanks falling into the hands of our troops at one place, one is justified in supposing that they had run out of fuel. But for our air supremacy the enemy would doubtless have been able to bring up all the fuel he required.

An interesting sidelight is thrown on the air side of the battle by the despatch which the New Zealand commander, General Freyberg, V.C., sent to his Government on the first stage of the battle. It will be remembered that General Freyberg commanded the Empire troops in Crete, and knows well what it means for soldiers to fight without air support. In the course of his despatch he wrote: "In my opinion the degree of success would depend on relative air strengths and the result of the armoured battle. In the air the R.A.F. established complete mastery, similar to the *Luftwaffe's* in Greece. The methods now employed have been really effective, and with more practice will be a great factor in the ultimate success."

Those words "with more practice" set one wondering. They read as if something novel had been tried, which was sound in itself but had not been practised sufficiently before the battle was joined. Until all the facts are before us it would be useless to speculate on what the New Zealand commander had in mind, but evidently he considered that there had been something wanting in the preliminary training for the battle. He suggests that that training was being acquired during the battle instead of having been carried out before it; and that is an expensive way of fighting. We must await further information before attempting comment.

The Bombing of Pearl Harbour

SOME relief may be felt on reading Col. Knox's report of the damage done to the American fleet by the apparently entirely unexpected Japanese air attack on Pearl Harbour, in the Hawaiian islands. The chief loss was the battleship *Arizona*, of 32,600 tons, which was built in 1916 and modernised in 1931. The *Oklahoma*, of 29,000 tons, dates from the same year and was modernised at the same time. She turned turtle, with grievous loss of life, but can, the Americans say, be made fit for action again. The old target ship *Utah*, which the Japanese seem to have mistaken for the carrier *Lexington*, probably does not matter much, and the loss of three destroyers and one minelayer will not cripple the United States naval strength. The important fact is, as Col. Knox has stated, that "the entire balance of the Pacific fleet, with its aircraft carriers, heavy cruisers, light cruisers, destroyers and submarines, is uninjured." and that the Japanese had failed entirely in their object to knock the U.S. Pacific fleet out before war was declared.

So far there is no evidence to suggest that the Japanese used torpedo-aircraft in this treacherous attack. Evi-

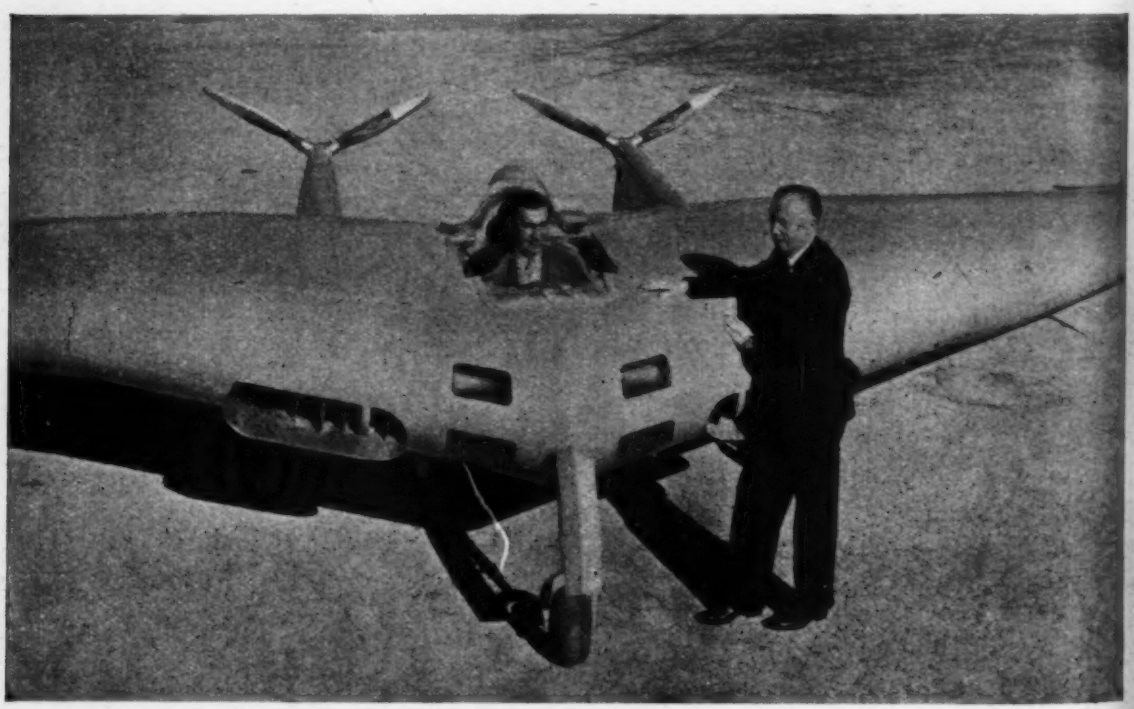
dently at least two carriers were used, and the weapon seems to have been the bomb, though it is reported that considerable damage was done by two-men submarines of 45ft. length, some of which were destroyed and one captured. The American fleet, including battleships and carriers, is now at sea searching for the Japanese fleet, and aircraft on both sides must be scouring the Pacific Ocean far and wide. It is an enormous tract of water, where evasion should be possible for a long time. But, leaving Malaya out of account for the moment, the Japanese have tied themselves by landing troops on various islands, and such troops must necessarily have naval support. That fact will give the American Admiral a clue as to the direction in which to send out his scouting aircraft, and may lead to interesting developments.

Changes in Command

PRESIDENT ROOSEVELT has ordered a searching investigation into the "apparent unpreparedness of the Army and Navy Forces in Hawaii at the time of the Japanese attack on December 7th." An authoritative board has been appointed to conduct the enquiry, with Justice Owen Roberts, of the Supreme Court, as its chairman. At the same time, Lieut. Gen. Walter C. Short has been relieved of his command of the Hawaiian Department, and has been succeeded by Lieut. Gen. Delos C. Emmons, of the Army Air Forces Combat Command. It is worthy of note that an air officer should have been chosen for this post. Likewise, Admiral Husband E. Kimmel has been relieved of the command of the U.S. Pacific Fleet, and is succeeded by Rear-Admiral Chester V. Nimitz.

These steps do not mean that the officers who have been relieved of their commands have been condemned before they were tried. The War Department at Washington has explained that they could not do their duties while involved in the investigation ordered by the President, and that is quite understandable. While the matter is *sub judice* it would be improper, especially for a foreign paper, to assume that the Americans were culpably negligent in being taken by surprise. Japan struck before war had been declared, and in places we Britons were also taken by surprise. Although the sending of capital ships to Singapore showed that the War Cabinet was alive to the danger of Japanese moves, the Governor of the Straits Settlements, Sir Shenton Thomas, has stated: "The initial surprise attack with no declaration of war . . . has made things very difficult for us. They have not gone as we hoped." The public at home certainly expected that we should be predominant in the air in and round Malaya, but in the first round that advantage has lain with the Japanese.

We should also remember that since the outbreak of war we have changed the Chief of the Air Staff, the Commanders-in-Chief of the Fighter, Bomber, Coastal, and Middle East Commands, besides making various changes of the officers holding the positions of Chief of the Imperial General Staff, and Commander-in-Chief at home, in the Middle East, and in India. The latest change has been in the command of the 8th Army in Libya. By no means do all of these changes reflect on the ability of the officers who have been superseded, and so we should be all the more slow to assume that blame should be imputed to Admiral Kimmel and General Short. We must wait for the findings of the Court.



AERODYNAMIC REFINEMENT: The Northrop tailless all-wing monoplane, which is a flying scale model of a much larger military aircraft. Interesting features which result from the all-wing ideal in a craft of small size are the retracting nose wheel, the air scoops in the leading-edge which direct cooling air to the engines inside the wing, and the windows for the pilot, whose view does not appear to be very good. On the right is Mr. John K. Northrop, talking to pilot Moye Stephens. A flying picture is on page 5.

War in the Air

REMINISCENT OF LONDON : An air raid in progress over Moscow. The Kremlin is silhouetted in the foreground.

Malaya Invaded : Hong Kong Besieged : Sarawak Oil Plant Removed : The Long Libyan Battle : Russian Advance Continues

THIS is a stirring week. Attention and interest are divided between the Japanese attacks on Malaya, Hong Kong, and the American islands in the Pacific, the battle in Libya, and the Russian advances west of Moscow and down near the Sea of Azov. At the same time the R.A.F. raids Germany and the occupied coast whenever the weather permits.

The loss of Kota Bahru and other airfields in northern Malaya has certainly handicapped us. The Governor, Sir Shenton Thomas, has stated: "The initial surprise attack with no declaration of war, and the decision of the Thai Government to afford every facility to the enemy—even though that decision was taken by duress—have made things very difficult for us. They have not gone as we hoped."

However, the Empire air forces have not been inactive. Reports are now coming through, and we have learnt that R.A.F. Blenheims and R.A.A.F. Hudsons sank a lot of the boats and barges which brought the Japanese troops ashore. Unfortunately, there were not enough aircraft on the spot to sink the lot. We have also heard of an Australian pilot in a Brewster Buffalo fighter who was attacked by six Japanese fighters as he was about to land on his airfield. He shot down two, but his petrol was finished and he had to crash-land somewhere. The Australian was unhurt.

Hong Kong has been heavily attacked by the Japanese, and the suburb on the mainland, Kowloon, has been evacuated. One may hope that the R.A.F. airfield at Kai Tak is no longer usable, for it must have been occupied by the enemy. The town on the island of Hong Kong has been both bombed and shelled. The defences of the colony are hitting back manfully, and Chinese forces, with admirable chivalry, have launched a fierce attack on the Japanese rear near Canton in an attempt to relieve the pressure on the British colony.

IN THE LIBYAN BATTLE : A Maryland bomber of the South African Air Force bombing enemy transport. Smoke can be seen rising from vehicles which have been hit.

In Libya

IN Libya Gen. Rommel has been retreating slowly westwards, fighting as he went, but apparently trying to extricate what is left of his armoured forces, regardless of loss of territory. The garrisons at Sollum, Halfaya, and round about, have been left to their own devices, and must soon fall into British hands. The tactics of Gen. Ritchie are to get a strong force round to the rear of the retreating Germans, and so encircle them. The Germans have been making reckless attempts to reinforce their air strength in Libya, knowing well that while the R.A.F. and the Dominion air forces continue to master the skies, it is impossible to ensure supplies of petrol and other necessities for Rommel's forces. Junkers 52 troop-carriers have been flying in numbers across the sea to Africa, probably bringing supplies rather than men, and Ju 87 dive-bombers and other classes of aircraft have appeared over the battlefield. Whether these machines have all come from Italy and Sicily, or whether some of them have been drawn from the fighting front in Russia or from dealing with the patriot risings in Greece and Serbia, cannot be said. Certainly the *Luftwaffe* has been stretched to its

WAR IN THE AIR

limits, or even beyond. The Russians are reported to have gained air superiority on many parts of their front, and a further withdrawal of German aircraft from there would seem to be a hazardous step. Yet, despite increased opposition, the British machines continue to hold a decided supremacy in Libya. The fighters have shot down many Ju 52s, and have tackled the Stukas and other bombers, and prevented them from holding up the advance of our troops. New Zealanders have shot down some enemy aircraft by fire from the ground. All the time the destruction of enemy supply columns has been going on, and one squadron of Beaufighters deserves particular credit for having destroyed over 50 enemy aircraft (some in the air, some on the ground) in the first fortnight of the battle, in addition to playing havoc with road transport and petrol dumps. A squadron of the Fleet Air Arm has specialised in night bombing, and has spoilt the sleep of many enemy supply convoys after they had gone into laager for the night in the desert. Bombing attacks on the enemy ports in Libya, Sicily, Italy and Greece have been carried out with great regularity; and with all this activity and daring the Middle East Command rarely loses more than a very few aircraft. Even aircraft which fail to return are not always total losses, for some time ago it was reported that 27 of our fighter pilots had found their way back to our forces after having been shot down, and one brought his Tomahawk with him, having persuaded an armoured car to tow it for 50 miles across the desert at an average speed of seven m.p.h.

FLYING ON ITS REPUTATION: The crew of a Western Desert Beaufighter standing by their machine after bringing it back over 400 miles after losing three feet from the starboard wing. They were ground-strafing enemy transport and failed to notice a telegraph post.

The Americans are to establish a great base in Eritrea for repairs and erection of aircraft, tanks, and other equipment for the Allied forces in the Middle East. It will be well outside the range of enemy bombers, and should be of great help to General Auchinleck. It is stated that there is no suggestion that the United States intends to take over the former Italian colony.

The Japanese, making the most of their temporary naval control of the Western Pacific, have made a landing at Miri in Sarawak, the independent State in Borneo ruled by the Brooke family of British Rajas. Evidently they hoped to get oil from there, for they must be perilously short of that commodity, but the oil plant had been removed before they arrived. Most of Borneo belongs to the Dutch, and a bomber of the Royal Netherlands Navy scored a direct hit on a Japanese destroyer which was covering the landing.

Japanese troops are closing round the shore opposite the island of Penang on the west coast of Malaya, and the city has been bombed several times. It is regarded as the most beautiful and desirable city in all Malaya. Ipoh is another Malayan station which is said to have been bombed, but reports that Rangoon has also suffered that infliction have not been confirmed up to the time of our going to press.

PARATROOPSHIP: Personnel of what is known as the Special Air Service emplaning on a Bristol Bombay in the Middle East.

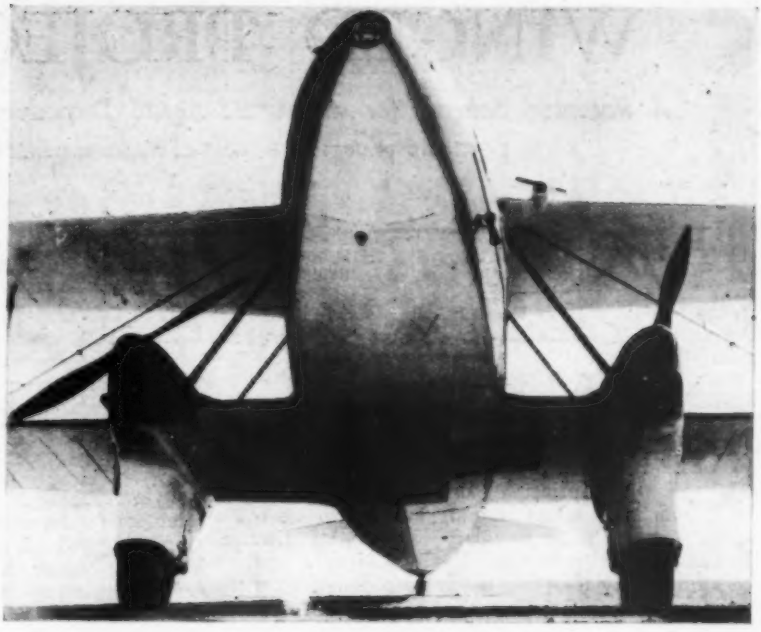
Australia's Danger

AUSTRALIA has always been alive to her danger in the event of war with Japan, and women and children are being evacuated from Darwin. Consultations are also going on with the Home Government about the strategic disposition of the Royal Australian Air Force. The Commonwealth is now one of the great arsenals of the Empire, and the Premier, Mr. Curtin, has decided to give priority to the production of aircraft. Australians realise, however, that their safety depends on Singapore, where many Australian troops and R.A.A.F. squadrons are now stationed.

The R.A.F. at home has continued its bombing operations whenever the

weather has permitted, and Wilhelmshaven and Brest have been among the targets recently attacked. A Beaufort has torpedoed and probably sunk a *flak* ship off the Dutch coast, while a sergeant-major of the Royal Netherlands Marine bombed and blew up an ammunition ship off the Norwegian coast.

On Thursday, December 18th, a heavy daylight raid was made on Brest, where the *Scharnhorst* and *Gneisenau* are still berthed. It appears that both are now in dry dock; in earlier raids only the *Gneisenau* was thus laid up. The raid was made by a powerful force of heavy bombers—Stirlings, Halifaxes and Manchesters—and there was a strong escort of Spitfire and Hurricane squadrons. The defences showed intense energy, both by fire from the ground and by the use of fighters. The air fighting above the raid was intense, and the escort shot down four enemy fighters for the loss of one. Some of the enemy defenders succeeded in getting within range of the British bombers, who shot down four more of them. Five of our bombers were lost. Bombs were seen to burst on the dry docks in which the two battle cruisers were lying, and it is believed that both were damaged. It was an exceedingly gallant show by our airmen, and, considering all things, our losses were not unduly high.



FOR URGENT CASES: One of a number of D.H. Rapide ambulances now being used in the Battle of Libya. Seriously wounded men can be taken in comfort direct to base hospitals.

Rommel's Retreat

ON December 17th the Axis forces in Libya, having been defeated by an Indian division when they made a last desperate counter-attack four days before, abandoned further resistance and began to retreat in something like disorder. As a matter of fact, they had been retreating for some time before, though in good order and fighting as they went. While we all feel a natural exultation at this news, it should be remembered that from the beginning of the battle the British commanders declared that our object was not so much the gain of so many square miles of desert as the destruction of the enemy's armoured forces. A large proportion of them has been destroyed, but the reports suggest that the German heavy tanks have continued to provide a problem. What we at home hope to hear now is that these tanks have been put out of action and have not succeeded in getting away to a base from which they can sally out to fight again. Empire aircraft are energetically harrying the flying enemy.

FIGHTER HOSPITAL: A Spitfire which has received a hit in the fuselage from a cannon shell arrives at a repair depot.

Moves in the Pacific

AS we go to press the Japanese claim to have landed on Hong Kong island. The artillery of the colony had silenced a number of Japanese guns. The air raiding had not been very heavy, and the A.A. guns had driven off some Japanese bombers and brought down a few more. Life in the colony had been pursuing a normal course, but the place had been provided with fine raid shelters for use if necessary.

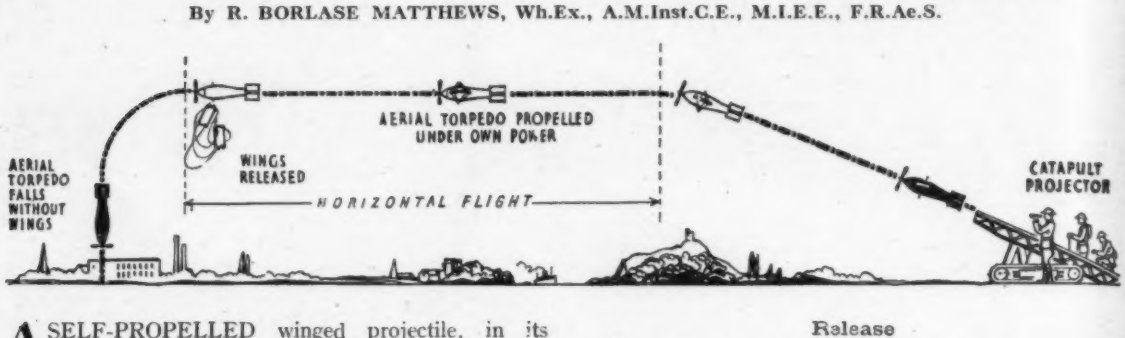
In Malaya the British forces have been withdrawn from Kedah State, and have formed a new line to the south of Penang. This is not good news, and it is possible that the situation has once more been determined by the enemy's superiority in the air. General Wavell has moved more Indian troops into Burma, and the rumour that Rangoon has been bombed has been denied.

Forces of the A.B.C.D. Powers have occupied the Portuguese island of Timor to prevent it from becoming a base for attacks by air and sea against Australia.

WINGED PROJECTILES

A Patented Scheme for Automatic Aerial Torpedoes or Shells or Bombs

By R. BORLASE MATTHEWS, Wh.Ex., A.M.Inst.C.E., M.I.E.E., F.R.Ae.S.



A SELF-PROPELLED winged projectile, in its underlying principle, differs very considerably from both target aircraft and automatic robot piloting devices as an auxiliary for ordinary aircraft. The self-propelled projectile is really a form of artillery and an auxiliary thereto. It has been designed for the conveying of projectiles, shells, bombs, torpedoes or other explosives, and also propaganda leaflets, to predetermined spots at distances which are beyond the reach of ordinary artillery. It does this in a more economical manner than could be accomplished by pilot-driven machines, and also, which is of more importance, in far greater numbers.

It has the following advantages in comparison with artillery:—

(a) A greater range;
(b) Most of the transport difficulties of moving heavy artillery are obviated;
(c) Repairs to rifling, etc., are eliminated; and
(d) The speed of the self-propelling projectile is constant—a projectile from a gun has, of course, a diminishing speed, falling all the time (owing to the form of initial impulse).

The self-propelling projectile consists of any suitable projectile, shell, torpedo, bomb, etc., which is built into what is really a pilotless aircraft, complete with engine, airscrew, gyrostatic controls, release-timing device, etc. In other words, it is a projectile with wings. A peculiar feature is that it sheds its wings automatically when it is at the appropriate distance from its target. This is done to ensure that it may not be diverted from that target due to the effects of any currents of air on the machine which might take place if it were permitted to glide when the engine was stopped.

Launching

This is preferably carried out by means of a catapult, as this considerably reduces the size of engine required to propel the projectile. The same scientific principles that are required for laying artillery will have to be applied in launching it, i.e., consideration will have to be given to range-finding, temperature, barometic pressure, drift due to wind and air currents, time-setting of fuse or equivalent, height of flight, trajectory, etc. When the initial impulse of the catapult launching is expended, the projectile continues its flight by means of its own engine power. It maintains its direction, height and balance by means of a special gyrostatic pilot built into the machine, hand-started by a cord, and then operated either by the exhaust of the engine or by compressed air.

Release

On reaching a predetermined point, the propeller motor is automatically stopped and the wings released and dropped off. The projectile will then become an ordinary bomb, and with a small trajectory will fall vertically on to its objective. If the wings had been allowed to remain on after stopping the motive power, the apparatus would glide down, and hence its point of striking the ground would be very uncertain, as it would depend largely on the vagaries of any local upward air currents. This difficulty is overcome by dispensing with the wings when its destination is reached. In flight, ailerons, tailplanes and rudders would be operated by the gyropilot in the customary manner as employed in human pilot robot-controlled aircraft.

Construction

A propelling chamber, complete with airscrew, petrol engine and gyropilot, is fitted in a casing that, in turn, fits over the front portions of a standard aerial bomb. The chamber also has in it the gyro-actuated controls for the ailerons, rudders and elevators. The length of flight is predetermined (a) by measuring out a definite quantity of fuel; (b) by a time clock mechanism; (c) by means of a pin or other form of interrupter fitted on an engine counter; or (d) by means of a distant wireless signal from a control point on the ground. The petrol propelling engine (or, alternatively, a compressed-air motor driven by compressed air contained in a separate storage cylinder) is purposely made of a very light construction of drawn brass tubing and pressings.

This not only makes the engine very light (in fact, less weight per h.p. than the average aircraft engine), but also reduces its first cost, as, after all, it is only used for one flight and is then destroyed in the explosion of the bomb. There is no need to have an engine capable of operating longer than that required for the flight, and hence methods of design can be adopted which would be impracticable for an engine which had to work for considerable periods.

The wings, which are of the usual aerofoil section, are held to the body of the projectile by means of wire stays which press the pivots on the inside ends of the wings into indentations on the side of the self-propelling aerial torpedo shell. On the release of a trigger toggle these stays collapse and the wings fall off, so permitting the projectile to fall freely at a predetermined spot without being encumbered, and possibly misdirected, by the wings which conveyed it to the spot. The wings are of very cheap construction, without rounded ends or other

modern refinements called for in high-speed aircraft controlled by human pilots, where efficiency is of the utmost importance. The wing ribs are stamped out of plywood or pressed cellulose, to minimise the cost of construction.

General Design

This is on sound, though exceedingly simple, engineering lines. It is proposed to use standard bombs so as not to interfere with the routine manufacture of the latter. The equipment containing the power unit, timing mechanisation, gyroscopes, etc., is designed on engineering lines for mass production, as one of the objects is to render available a very large number of the complete projectile units in as short a time as possible, and also to make possible their use in very large numbers.

There has been a very considerable development in the design of gliders and model power-driven aircraft during recent years and also catapults and other projecting divides therefor, which have their application to the self-propelling projectile. Then, again, considerable work has been done on special pilotless targets, which, though on quite different lines, can be usefully applied to this newer projectile.

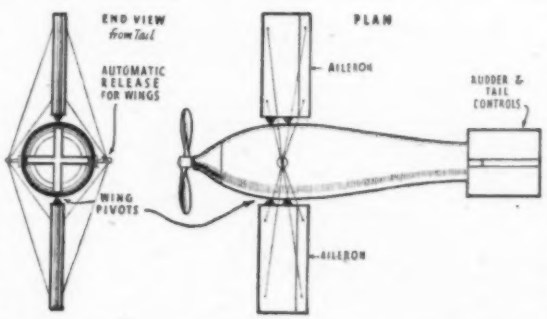
The wing area is designed to carry the combination of the fuselage, a light engine, the petrol fuel, the automatic pilot and the load. The indication is that a usual load would be 40 lb. Owing to the mounting of the inner ends of the wings on pin points, and the fact that the stays are released underneath by a toggle lever action, on release, whatever be their size, they naturally and automatically fold upwards, and owing to their greater surface are lifted clear of the chassis which, immediately its support is removed, commences to drop.

Gyrostatic Control

The self-propelling projectile is maintained in its direction of flight by means of a new form of simple gyrostat, acting in two stages to prevent hunting and to secure steadier flight. The gyroscopes are arranged for operation by directing the exhaust gases from the engine, through jets, on to wing-section fan blades affixed to the rotors. In the present design the initial spin to the rotors is given by the pulling of a cord wound around their spindles, though, of course, they would build up their speed by running the engine for a few minutes.

Range

Normally the apparatus is designed for a range of about double that of long-range artillery and for a life of under half an hour. For use at exceptional distances, say, of over 100 miles, an entirely different design is required, with much better workmanship and, of course, at much higher cost.



Effects of Weather

The projectile is certainly very much more at the mercy of the elements than a shell, and everything would depend upon a good estimate of the weather conditions *en route* on a very long flight. However, if a serious attempt were to be made on a target at a great distance, a considerable number of aerial torpedoes would be set off at about the same time, with slightly different corrections. This would ensure that about one-third of them would reach approximately the centre of the target.

Obviously, an aerial torpedo would be timed to reach distant places in hours of darkness, otherwise in daylight enemy aircraft would chase them and shoot them down and at no danger to themselves, as there would be no shooting back. However, even in that case, the bombs would have to explode, though probably over the country. The speed would be lower than that of a shell, as it is required to keep the engine power down to a minimum and also to reduce the noise as much as possible.

Previous Work

At first sight this invention might be considered as one of which the principles are well known or that no novel features are disclosed. A careful study of the subject, however, demonstrates that it is quite original as regards anything that has been published so far, or tested in practice. There have been various references in the popular Press from time to time to "aerial torpedoes." None of these, however, are along the specific lines of the self-propelling projectile described in this article.

Target Aircraft Failure

In view of their past unfortunate experiences with *target* aircraft—chiefly due to attempts at radio control—the authorities feel that the new weapon could not be sufficiently reliable. Of course, it is no use to attempt employing radio control, as this could be so easily interfered with by the enemy. While the present loading indication is of 40 lb. lb. sq. ft., there is no reason why almost any size load could not be carried; but with very large weights the machine would have to be nearly the size of a piloted aircraft, and in that case it might be considered advisable to employ a pilot, as the loss would be very serious if the load did not reach its target.

While the aerial bombing of a distant place is a great attraction to the imagination, the real field for this new weapon is the possibility of using it in very large numbers, as they are very easily and cheaply made, for the same purposes as artillery, but at two to three times the range. The catapults are light and easily transported, and, therefore, could be moved into more forward positions than guns; or, alternatively, they might be placed farther behind the normal positions for guns, as a little increase in the range would not be serious.

Cost

Apart from the preliminary experimental work, and under conditions of mass production, it should be possible to produce the power-propelling unit, wings, etc., complete, except for the aerial bomb or shell, for under £25 each, which, it is estimated, is less than the cost of firing a shell from a gun, when the total costs are included, e.g., the transport of the gun and the shells and explosive charges, and also for maintaining and rerifling the gun. Further, it must be taken into account that the range of the projectile is very much greater than that of a gun, and also the unit is very much lighter.

Unsuccessful Pilotless Aircraft

Various forms of pilotless aircraft have been designed before, but for various reasons they have not been

WINGED PROJECTILES

successful. The present form has overcome the defects of its predecessors, and can be used with the accuracy of a gun, and will, of course, require similar calculations for angular fire, side drift, barometric pressure, etc. While this device is intended generally for hitting points well beyond the range of ordinary guns, it could, in an extreme case, though not with any great degree of accuracy, hit a city 100 to 500 miles away. A different and more precision-like construction is needed for extra long range of this kind. For ranges of about double that of ordinary guns, the whole apparatus can be made more cheaply, and can, therefore, be employed in large numbers. The device is not usually equipped with wireless control, as, so far, it is impossible to avoid counter-control by enemy action.

Another application of this apparatus is for the distribution of propaganda leaflets. Balloons are being employed for this purpose, but they are subject too much to the vagaries of the wind, and hence cannot be relied upon to reach definite objectives.

Historical

Though really a distinct and separate subject, it is of interest to consider the work that has been done on automatic controls and on target aircraft.

Very early in 1909 Marmonnier described an automatic stabiliser for aircraft. Dr. Lee de Forest carried out experiments in the wireless control of aircraft during the last war. At Farnborough, in 1917, and at Northolt, in 1918, other experiments were made with wireless control.

A great deal of work has been done in gyroscope controls for the assistance of pilots—the best-known applications being those of the Sperry and R.A.E. systems.

The next stage was the development of aircraft for *target practice* initiated by Reginald Denney and others. The most famous later examples in this direction that were seriously tried under practical conditions were the "Queen Bee" and the "Queen Wasp" types. However, they proved to be too costly and too erratic in performance. Recovery was difficult, and generally considerable damage was caused to the targets in falling, even on the sea. Denney used parachutes which came into operation when the petrol for the engine was exhausted. A number of experiments on target machines was also made in Germany in 1918. Again in 1936 another German radio-controlled aircraft was tested successfully, but eventually it was decided not to proceed further with this target work.

Experiments with pilotless aircraft controlled by wireless apparatus have not been at all successful. The main reason would appear to be the ineffectiveness of the controls and insufficient quickness in response. However, the object of a pilotless aircraft target is to manœuvre it in the sky. In the case of the self-propelling projectile, it has only one straight, definite flight to make, which entirely obviates the need of the form of controls required in a pilotless aircraft target. The self-propelling shell can be projected with all the accuracy of gun laying; its only defect is that as it moves very slowly compared with an ordinary shell, it is more likely to be deflected by a cross-wind. After all, an ordinary shell is blown out of its path by a cross-wind, and all control of it is lost after it is fired. Experienced artillerymen make allowances for cross-winds when firing a shell. Not only are there cross-winds to contend with, but gusts and eddies. However, even these can be very largely corrected by means of a few experimental shots.

No references can be found in books, journals, scientific papers, or patent specifications that anticipate the self-propelling projectile and its applications as herein described. The nearest approach is the small pilotless aircraft carrying a torpedo and mounted on the back of a piloted aircraft for release to fly independently when near its destination. These pick-a-pack arrangements were developed by Capt. Norman Macmillan and Mr. H. P. Folland.

Apparently no one has designed aerial torpedoes or aerial shells, or aerial projectiles or aerial propaganda leaflet droppers on the principles of the machine described in this article.

To sum up, a good deal of imagination and vision is required to conceive the real possibilities of this new weapon. In official quarters the chief objection of the authorities seems to be that it is an entirely new arm and would, therefore, require the development of a new technique in using it. Also there is the fear of contravening international war agreements. However, if the use is confined to the field of battle, as is the case with artillery fire, this objection does not arise.

WRIGHT WAS RIGHT

FROM time to time we have quoted from articles in our American contemporary, *Aviation*, by Mr. T. P. Wright, at that time technical chief of the Curtiss-Wright Corporation and now Assistant Chief of the Aircraft Branch of the Office of Production Management. An Editorial Comment in *Flight* of April 25th, 1940, was headed "Is Wright Right?" The answer is now forthcoming, and it appears to be "Yes!"

In the November issue of *Aviation* is published the text of a letter written by Mr. T. P. Wright, who explains (what one may well believe) that he finds it difficult to get time for writing articles, but that the curves from a previous article (January, 1941), with dots added to show actual deliveries, form the "meat" of the letter. That is only partly true, for there is much of interest in the letter itself. However, we have not the space this week to do more than refer to the production curves.

First of all it may be helpful to recall that in his predictions Mr. Wright made use of certain parameters governing output, chiefly those of factory floor space and labour man-hours. The dots on the reproduced curves show surprisingly good agreement in the case of American production. In some months the actual deliveries to the U.S. Army and Navy and to Great Britain were above and in others below the curve, but the average agreement is very good. It is pointed out that numbers of aircraft have lost some of their significance because of the change of policy which laid greater stress on heavy four-engined bombers which, of course, take longer to build than the smaller types.

American production figures are, of course, known to Mr. Wright, but not those of Great Britain and Germany. However, as he very justly remarks, "as the method used for the United States and England was the same as that used for Germany, is it not reasonable to suppose that the forecast for Germany also is close to the truth? Study of all available information on what is happening in Germany leads to the belief that it is."

Mr. Wright comes to the conclusion that, without counting Russia, the rate of production of England, augmented by one-half of the U.S. production, is now greater than the output of Germany and Italy. Total air strength of the Allies, Mr. Wright concludes, will be greater than that of the Axis Powers early in 1942.

ROM THE AIR FRONTS

Further Selection of Photographs of Air Operations

The Armstrong Whitworth Whitley, which has bombed targets as far afield as Milan and Prague. After more than two years operational flying it is still very much in service.

CONTINUING our series from last week, on this and the following two pages are more pictures of the Royal Air Force and the Empire Air Forces at war. Even so, despite the space we have devoted to this selection, only a tiny fraction of their activities can be shown.

By the very nature of warlike operations it is those shrouded by secrecy which are the most interesting. Nevertheless, it is the ordinary bomber, fighter or reconnaissance squadrons which do by far the greater percentage of war flying.

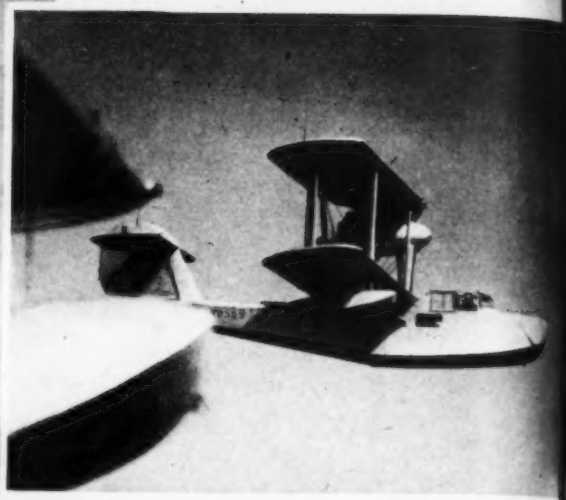
y and night heavy bomber.
e Short Stirling.

The Short Sunderland is another type which has seen service on every front. The North Sea, the Atlantic, Mediterranean and Pacific oceans are all patrolled by these four-engined boats.

t the outbreak of war the Saro Lerwick
as our fastest flying boat. It is in service
with Coastal Command.

(Above) Of all the types obtained from America, the Consolidated Catalina boat has been outstanding. The R.A.F. purchased one a year or two before the war.

(Left) After being used for stratosphere raiding from this country the Fortress is now in use in the Middle East. Its long range should show up to advantage. In the background is a Tomahawk and a Boston.

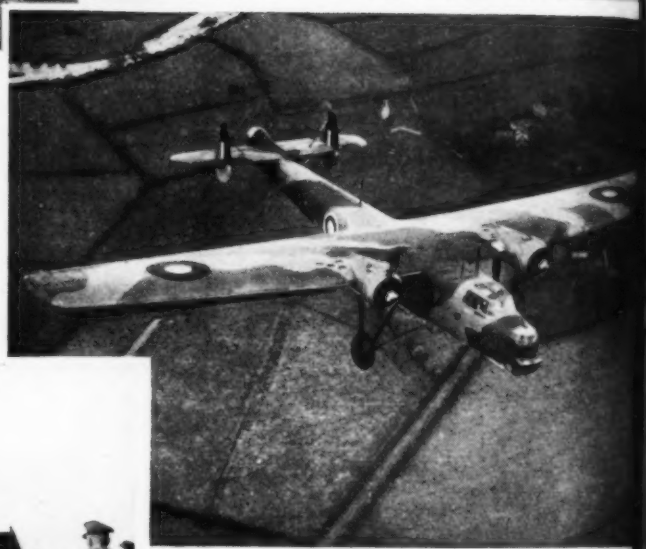


(Above) Carrier-borne or land-based, the Fairey Albacore will be in action wherever the Fleet Air Arm is to be found.

(Top, right) Britain's only amphibious type, the Vickers Walrus, is carried on most of our cruisers. Catapulted off, it is able to alight alongside its parent ship or proceed to the nearest land base.

(Right) The troop-carrying Bristol Bombay, which is now being used in the Middle East for parachute troops.

FROM THE AIR FRONTS

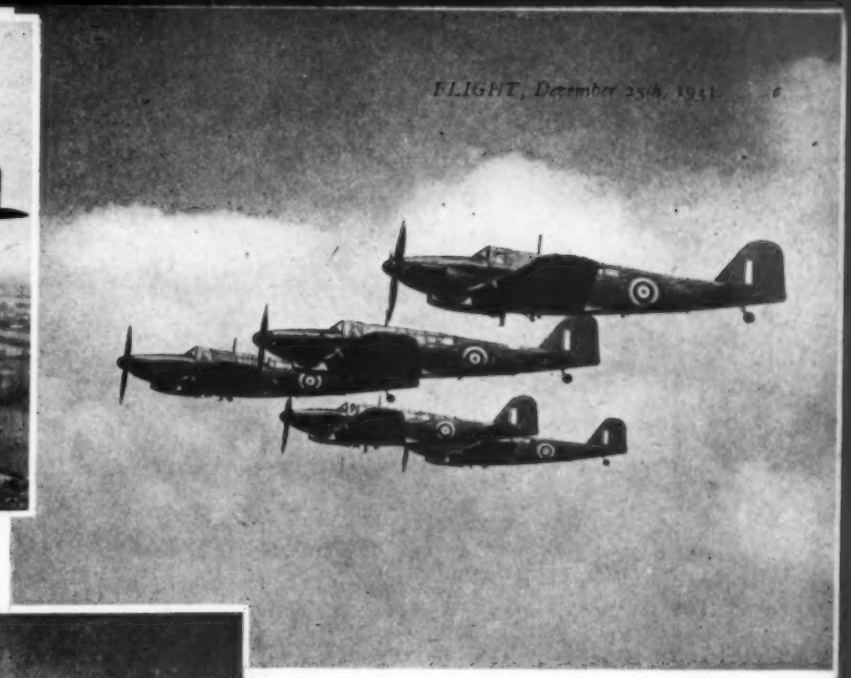


(Left) A three-engined Caproni which now sports the tricolour roundels and sees service with the R.A.F. in Egypt.

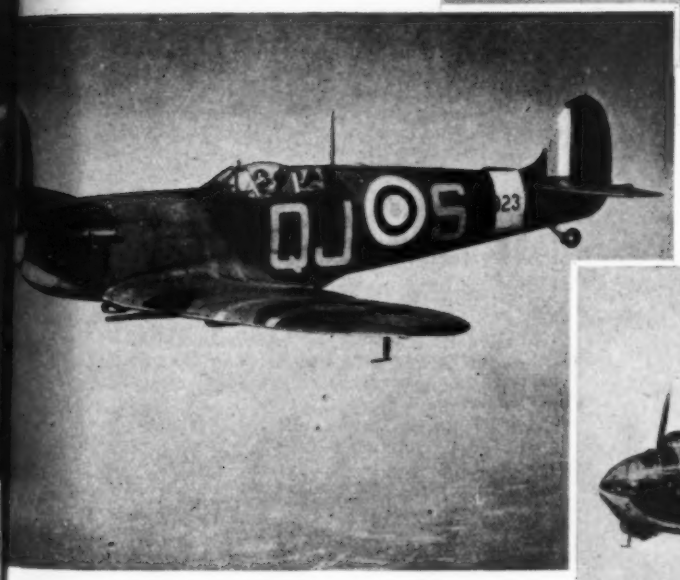
(Below) From the days of the short-nosed Mark I version the Bristol Blenheim has fought on every front in the war. This photograph shows a long-nosed Blenheim in day camouflage.

(Left) One of the most exacting duties of Bomber Command is the laying of sea mines. Handley Page Hampdens are used for this work in addition to night raiding with bombs over Germany.

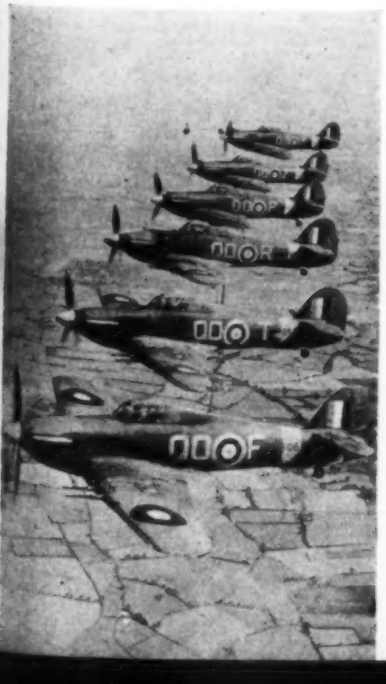
(Above) The old Mark I Whitleys with Tiger engines are finishing their flying careers as para-troop training carriers.



(Above) Another type which fights in the widely separated actions of the Fleet Air Arm is the Fairey Fulmar. This is the Navy's standard eight-gun fighter.
(Below) General purpose—for torpedo-carrying, bombing or reconnaissance—the Bristol Beaufort has made a name for itself in North Sea actions.



(Above) The cannon-armed Supermarine Spitfire V, which many pilots of Fighter Command consider is the ideal machine from a handling, fighting or speed point of view.



(Above) Vickers Wellington—the beloved "Wimpey" of Bomber Command—which operates wherever a bombing job has to be done.
(Left) A formation of cannon-armed Hurricane IIs of Fighter Command. These hard-hitting fighters have done excellent work ground strafing.

Topics of the Day

NEW CONVENTIONS

From Cannon Fighters to "Level Landing" Technique : The Tricycle Comes to Stay

AS I've said before, the middle of the biggest war in history is no suitable time for the designers and manufacturers of a country involved in this war to start playing about with new developments. Or, at least, with developments which do not promise immediate and definite advantages; these must wait until it is all over.

It has therefore been largely left to the Americans to design and produce aircraft with tricycle undercarriages and with quaint layouts such as that of the Bell Airacobra. No doubt similarly "different" designs are quietly on the way in our own factories, but it would obviously have been dangerous to spend too much time and money on layouts which might or might not have been successful at a time when we required more and yet more machines. Whether these were conventional or otherwise did not matter a great deal so long as they worked, and worked well.

The essential rightness of the policy in these particular conditions is proved by the way in which production has gone up and such types as the Hurricane have been successfully modified to do all kinds of work for which they were not originally designed. Sheer sturdiness and essential goodness in the Hurricane, for instance, have meant that more and more items could be piled on without affecting the performance to any marked extent.

Cannon Fighters

Incidentally, I believe that the cannon fighter will eventually do far better work than the dive-bomber—and without the tremendous loss of machine and man-power suffered by the Germans in the use of the Junkers 87. The latter have had to be used in enormous numbers to be at all effective, and when anything like a decent defending fighter force has been available they have proved to be cold meat. The good dive-bomber is not a good fighting machine, whereas the four-cannon fighter can be almost, if not quite, as good as its eight-gun or four-gun counterpart. If bombs *must* be used to complete the destruction, there is no reason why the cannon fighters should not be followed by waves of precision bombers after the objectives (what a word! Human objectives; human pincer movements; human pockets of resistance; humanity mopped up . . .) have been sufficiently harassed and partially immobilised by repeated dive attacks. But we must have tank-busting calibres for our cannons.

Tricycle Problems

In the meantime, it is a good thing that one large country with up-to-date ideas and a vast productive capacity should be comparatively free to develop new and strange devices without the feeling that time and effort are being or *might* be wasted. The Airacobra might not have been successful—and we do not yet know whether the layout offers any really outstanding advantages for offensive flying—the Liberator might have been a failure because of some fatuous series of troubles with either the operation or the position of the tricycle undercarriage, and the Douglas B-19 has yet to be fully proved. While these types have been in process of development, in Britain we have been making more and more aircraft for which little or no guesswork has been necessary—Stirlings, Halifaxes, improved Spitfires and Hurricanes, and a number of types which are still, for the general public, merely names. Nearly all of them have been conventional—and, interestingly enough, nearly all the German types have been equally conventional.

Across the Atlantic the unconventional has become the conventional. I doubt if any large plane will be built in the future without a tricycle undercarriage. One or two firms are still hanging on to the old ideas, but the majority appear, for better or for worse, to have been "converted." Time will show whether the tricycle, as we know it, will be the final word in "level landing" gears. And it has not just been a matter of "sticking on" a new type of undercarriage; the problems involved, particularly in large machines, must have been considerable. There have been the difficulties of retraction and of finding suitable space for the nose wheel, difficulties of loading and weight distribution, to mention just a few. To be successful, a tricycle job must be just right—a perfect balance between weight distribution and elevator control—otherwise the machine will either pitch badly when on the ground and perhaps even break the tail when landing on rough surfaces, or it may need an incredibly long run for the take-off. Normally, the tricycle type feels as if it's never going to fly at all until the critical moment arrives when the speed is just right and it suddenly leaves the ground like a cork flying from a bottle.

Landing Attitude

During the later peace years I developed a very considerable interest in the tricycle, but I considered it only as a device for taking the pains out of the landing process—whether for the benefit of the private owner and amateur or for the transport pilot putting his machine down at night or in Q B.I. conditions. The war, and the appearance of specialised types, has shown that this is only one of the many advantages. Since war is war, I cannot enumerate them here, but I *can* point out the obvious fact that these advantages have not been gained without cost.

Take-off and landing runs are essentially and necessarily longer, other things being equal, and the tricycle layout could not have been considered as a rational one until means of retraction and "detraction" had become completely reliable; a heavily loaded aircraft without its nose wheel is just about the most dangerous device that can possibly be imagined. Brakes, too, must be faultless, since, after landing, there is practically nothing to stop the thing. The difference in drag between an aircraft landed tail down and one which continues in a level flight attitude must be felt to be believed. In fact, special air brakes for after-landing use might reasonably be developed—though the operation must be absolutely foolproof.

I can think of one type which provides a complete lesson in after-landing drag—the Hudson, which can be landed either normally or just held on its wheels until it has lost all speed. From initially similar approach speeds and heights this machine can be made to finish its run in half the distance if a full three-pointer is successfully attempted, though it is, I believe, still the normally accepted practice to push it on to its wheels and to hold it in a level-flight attitude until all speed has been lost. In that attitude, and with the Fowler flaps at "half-mast," its run is prodigious if no brakes are used. There is nothing to stop it.

Tyres and Braking

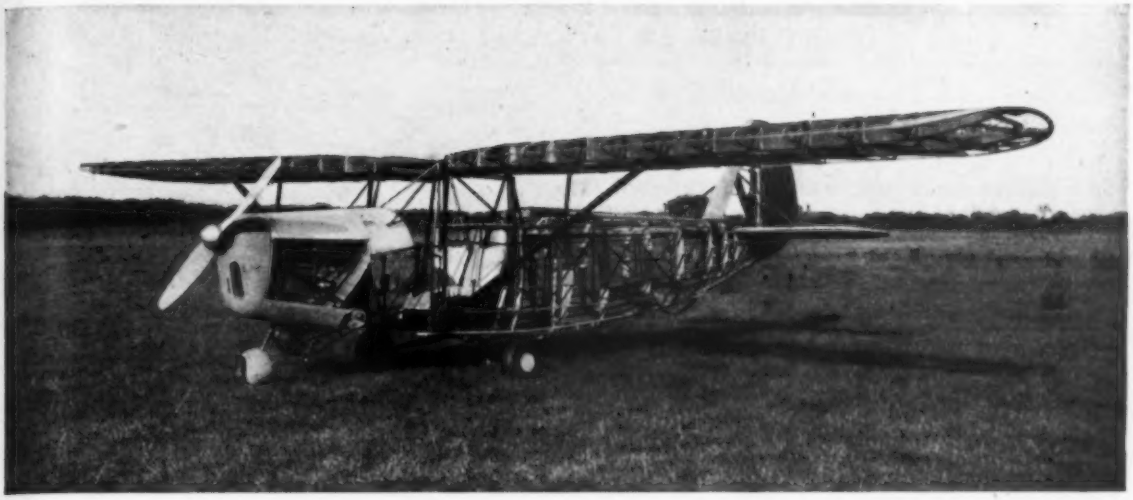
With a tricycle the pilot has no tail-down alternative, but he *can* apply his brakes as hard as he likes and as soon as he likes if the ground is sufficiently firm. Obviously, tricycles are meant for runways—and the tyre manufacturers can squirm as they watch the smoke pouring from all three wheels when a 25-tonner is put down on the tarmac at ninety-odd: unburstable tyres and "pre-landing rotatable" wheels are going to be necessities with these modern types.

After about a year pilots and ground staffs will begin to know all about tricycles. Quite a few types are on operations now, and the pilots certainly like them. When this war is over we shall have a good mass of information on which to work. Let's hope we make use of it.

"INDICATOR."

ADVERTISED GOODS

THE fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.



Work on this interesting light plane had to be postponed on the outbreak of war.

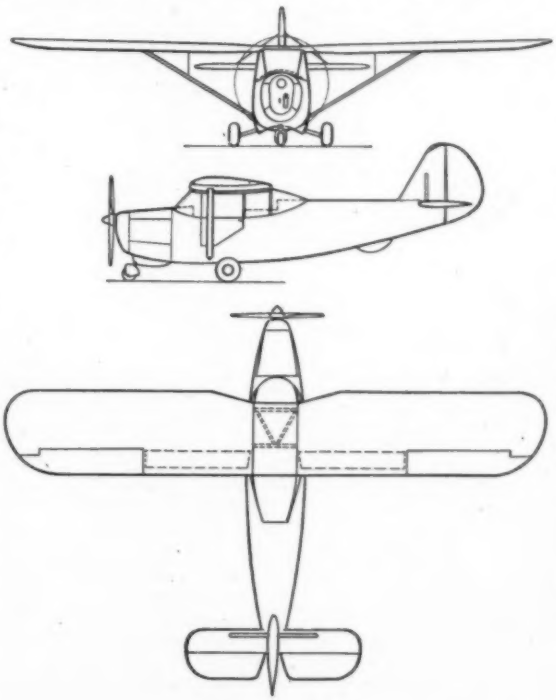
THE GUARDIAN

A Light Civil Trainer with Some Novel Features : Tricycle Undercarriage and Side-by-side Seating

DETAILS have recently come to hand of an attractive little trainer, of which no description has previously been published. The machine, a high-wing cabin monoplane with a tricycle undercarriage, was designed by Mr. J. H. Payne. The construction of the prototype was nearing completion at Peterborough at the outbreak of the war. Intended chiefly for Civil Air Guard training, the machine was to be named, appropriately, the "Guardian."

The machine was designed to full aerobatic factors. The three-view general arrangement drawings show the general layout, the photographs and sketches showing further details and the stage of construction reached.

The wings are rectangular in plan form, with rounded tips, and have a slight taper in thickness and local sweep-back of the leading edge at the inboard end. They are of wooden construction, having two parallel box-section spars connected by ribs and diagonal members. The leading edge, as far back as the front spar, is covered with stout pre-shaped plywood, the remainder of the wing being fabric covered. Both spars are pin-jointed at the root, and the wing is braced by a single strut attached to the front spar approximately half-way between the root and tip. The aerodynamic torque on the wing is taken internally, the necessary torsional stiffness being provided partly by the leading-edge box and partly by the system of diagonal bracing between the spars.



The ailerons, which have steel tubular spars but are otherwise of wooden construction, are aerodynamically and statically balanced. They occupy rather more than the outer half of each wing.

The inboard portions of the wings are provided with landing flaps, which are set forward from the trailing edge and let into recesses in the bottom surface of the wings. In order to reduce the operating loads the flaps are arranged to move backwards as they open.

With the exception of the elevator spar and rudder post, which are steel tubes, the tail unit is of wood. External bracing, in the form of a single strut on each side, connects the fin to the tailplane front spar. The tailplane and the leading edge of the fin are plywood covered. The rest of the tail unit is fabric covered. The incidence of the tailplane is adjustable on the ground.

The fuselage has a main structure of welded steel tubing and a light wooden fairing structure covered with fabric. Access to the cabin is provided by doors on both sides. The pilot and passenger, or instructor and pupil, sit side by side on "bucket" type seats, which are adjustable fore and aft. Full dual control is provided.

THE GUARDIAN

One of the problems always encountered when designing a small aircraft with side-by-side seating is that the legs of the crew tend to interfere with the lateral movement of the control column. In the Guardian this problem has been solved by the use of articulated control columns, i.e., only the upper portions hinge sideways. Organ-pedal type rudder controls are fitted, hinged below the heel.

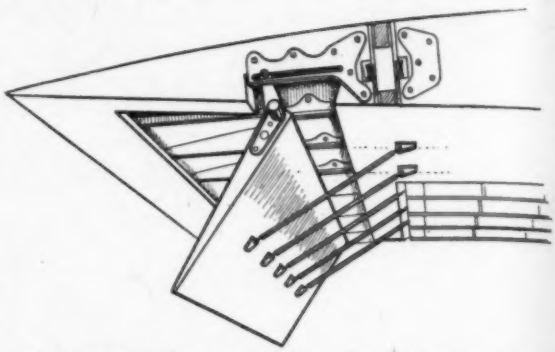
Particular care has been paid to the design and positioning of the engine controls. The pupil, who sits in the left-hand seat, uses his left hand for the throttle. This throttle lever is roughly in line with the front edge of his seat, at such a height that it can be used without raising the arm. An interconnected lever is provided for the instructor in a similar position on the right-hand side of the cabin. The other controls—the brake lever and longitudinal trimmer—are placed centrally.

A full range of instruments is fitted, including turn-and-bank indicator, fore-and-aft level and compass.

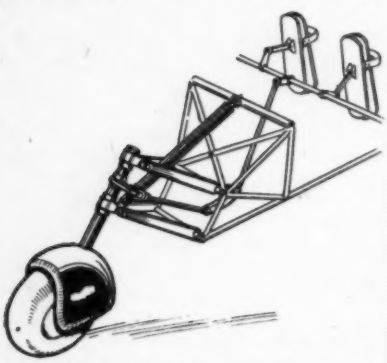
Undoubtedly the most interesting feature of the Guardian is the design of its tricycle undercarriage. The nose wheel is carried by a link mechanism, which enables the wheel to be placed well forward, under the engine. The "straight axle" is raked forward about 10 deg., and the wheel is steered by push-rods interconnected with the rudder control pedals. The main undercarriage is of exceptionally "clean" design, the only external parts being the tubular axles carrying the low-pressure wheels.

The engine is the Cirrus "Minor," the well-tried four-cylinder in-line inverted unit developing 80-90 b.h.p. Dual fuel pumps are fitted drawing petrol from a 20-gallon tank in the fuselage, immediately behind the cabin.

The Guardian affords an interesting comparison with the Taylorcraft trainer, a description of which was published in our issue of December 11th. Both have much in common with the ideal trainer which "Ex-R.F.C." discussed in his article in the October 2nd issue.



The landing flaps are arranged to move backwards as they open, in order to reduce operating loads.



The nose wheel has a parallel-link motion and is linked to the rudder pedals for steering.

Leading dimensions:

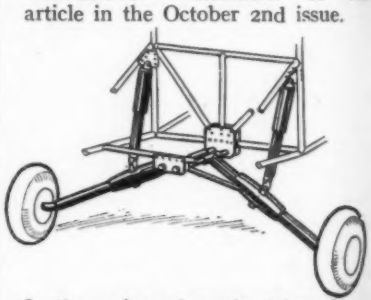
Span	33ft. 4in.
Length	23ft. 4in.
Height	8ft. 6in.
Wing chord	5ft. 0in.
Wing area (nett)	146 sq. ft.

Weights:

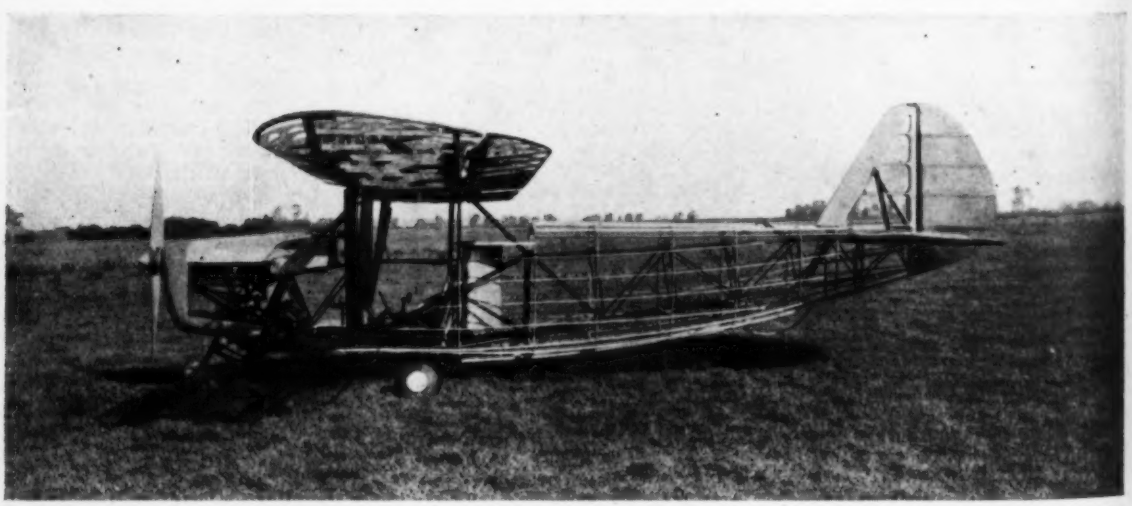
Tare weight	840lb.
All-up weight (acrobatic)	1,350lb.
Wing loading	9.25lb./sq. ft.
Power loading	15lb./h.p.

Performance (estimated):

Maximum speed	120 m.p.h.
Cruising speed	100 to 105 m.p.h.
Stalling speed (flaps down)	40 m.p.h.
Fuel consumption	3.5 to 4 gals. per hour.
Duration (approx.)	5 hours.
Range (approx.)	500 miles.
Rate of climb at G.L.	800ft./min.
Rate of climb at 10,000ft.	400ft./min.
Service ceiling	14,000ft.



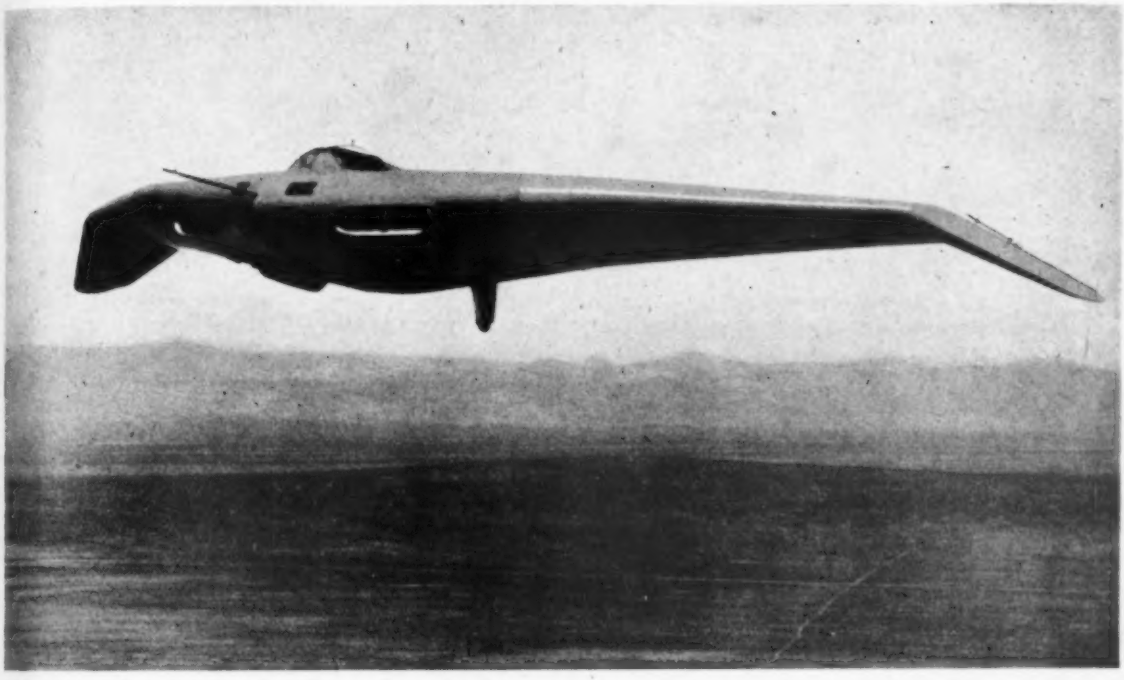
In the undercarriage the telescopic legs are inside the fuselage and are relieved of bending loads.



THE GUARDIAN IN SKELETON: The low ground clearance is partly due to the legs not being pumped up when the picture was taken.

TWO AMERICAN TYPES

"Flying Wing" and "Flying Fortress" Both Hail from California



The Northrop tailless flying "scale model" is claimed by its originator, Mr. John K. Northrop, to indicate that large aircraft can be built on these lines with a gain in speed of some 100 m.p.h. The model has made more than 200 test flights, and is said to handle like an orthodox aircraft. The significant feature of the design is at the wing tips, which are tilted down so that the control surfaces can act both as rudders and elevators.

The Boeing B-17E is the latest version of the "Flying Fortress." Slightly longer than the earlier models, and with a gross weight about 6 tons heavier, the most noteworthy features are the power-operated turrets in the fuselage and the gun position in the extreme tail.

Eighteenth of the Second Series

FRIEND or FOE ?

Two Fleet Air Arm Fairies : Albacore and Swordfish

ALBACORE. Cantilever tailplane with backswept leading-edge, round tips and straight trailing-edge with semi-circular "bite." Straight slope to leading-edge of fin.

OF the few biplanes still in operational service, the Albacore and Swordfish, from the famous house of Fairey, are probably the most numerous and most frequently encountered. The valorous exploits of these two machines have already been many, and their day is by no means over, yet!

Although the Albacore is larger than the Swordfish, and their wings, noses and undercarriages are different, it is in their tail units that they are, perhaps, most unlike each other. In a nutshell, the Albacore has a much neater tail design than its elder sister, and a quick glimpse of the tailplane alone should be sufficient to differentiate between them.

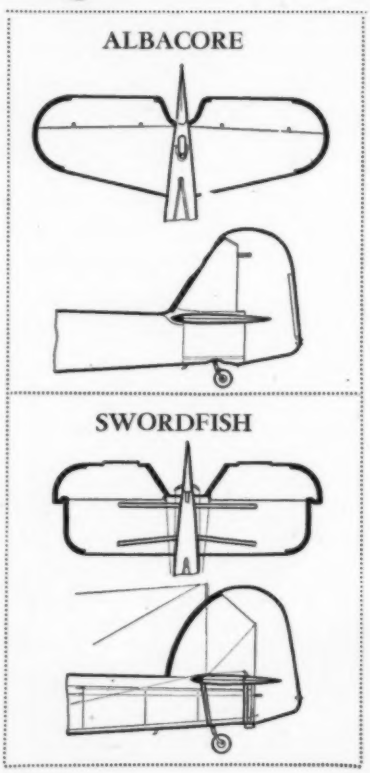
As will be seen from the accompanying drawings, the tailplane of the Albacore, of the cantilever type, is backswept on its leading-edge to well-rounded tips, the trailing-edge being straight except for a small semi-circular "bite" where the inner edges of the elevators are cut away to give rudder clearance. It is mounted level with the base of the fin. That of the Swordfish, however, is of an irregular pattern which may be said to have a rectangle as the fundamental basis of its design, and the best way of "describing" it is to refer the reader to the appropriate adjacent drawing in which the outstanding points for identification are thickly outlined. This tailplane, also, is braced by two external struts and, although mounted level with the base of the fin, is set well back in relation to the foot of the fin's leading-edge.

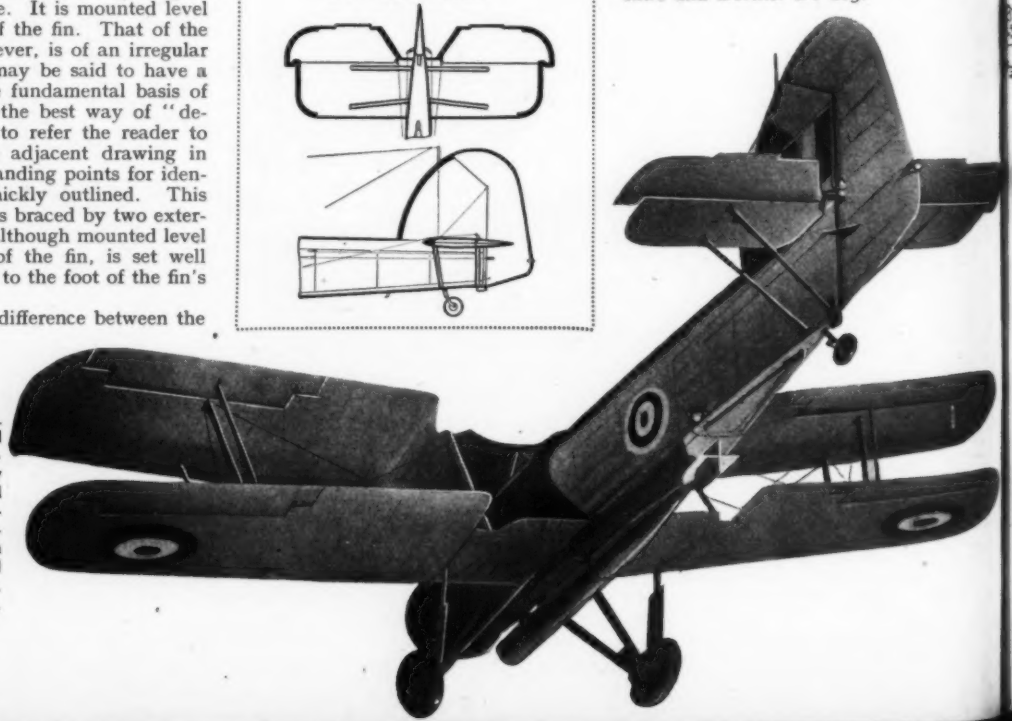
The essential difference between the vertical surfaces of these two tail units is also readily seen; the fin of the Albacore has a straight slope to its leading-edge and a fairly broad, round apex, while that of the Swordfish forms a bold convex curve of which the broad apex is but a continuation. Trailing-edges of the rudders are, for all practical identification purposes, almost identical; each has a slight, straight slope down to the lower extremity where it meets the base-line almost at right-angles.

Both aircraft have fixed undercarriages and non-retracting tailwheels and any view from below and behind may disclose a torpedo being carried under the centre-line of the fuselage.

Incidentally, the Swordfish is frequently encountered with floats replacing its land wheels.

Next week: De Haviland Hertfordshire and Dornier Do 215.





SWORDFISH. Irregular shaped tailplane externally braced by double struts and set back in relation to leading-edge of fin, which makes a bold convex curve. Fixed tail wheel.

XMAS INTERLUDE

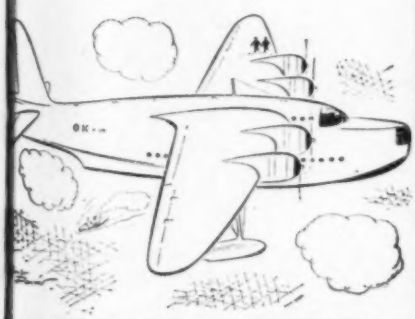
(*Flying and Popular Aviation*)

"This is the latest thing up here."

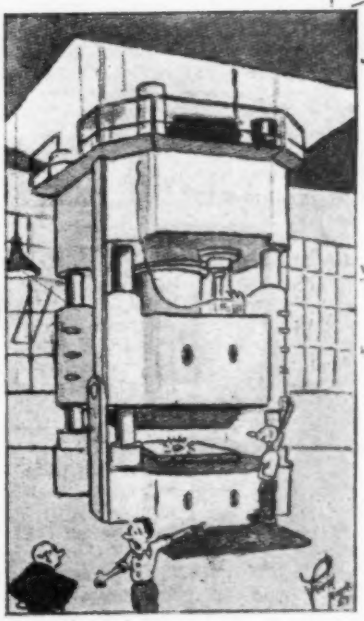
"It's a new design of my own."

(*Flying and Popular Aviation*)

"Pardon me, lady, I'm one of the para-troops on maneuvers."



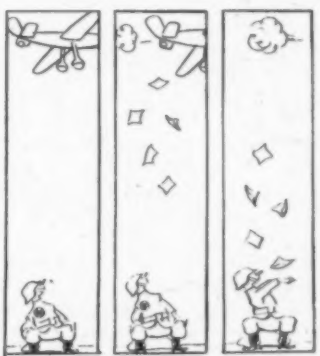
"Ten times round the wings is a mile."



(*North American Skywriter*)

"Cracking nuts in company time is bad enough, but Abernathy has no sense of proportion."

"Yes, that's better, but you're still landing with too much of a thump."



Breathes there an Erk with soul so dead,
Who has never turned around and said,
Hm-m m-m—not bad!

(*American Aviation*)

(Left) "I'm not going any place; I read in a survey that I'm safer here than I am at home."

(Right) And this is just a funny story in few words, told by a bright laddie in the R.A.F.

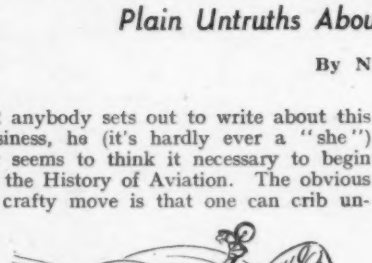
Xmas Interlude

AIRCRAFTINESS

A Member of the "Flight" Staff, Who is Old Enough to Know Better, Tells a Few Plain Untruths About This Flying Business

By N. D. R.

WHENEVER anybody sets out to write about this flying business, he (it's hardly ever a "she") invariably seems to think it necessary to begin with an outline of the History of Aviation. The obvious advantage of this crafty move is that one can crib unashamedly from one's predecessors, which is a very easy way of getting a flying start.



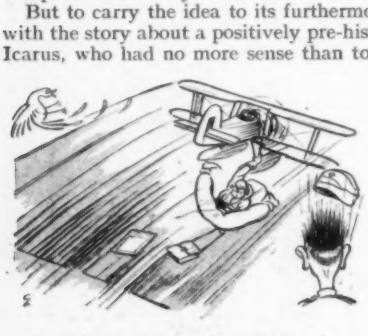
—launched into space in an unairworthy condition.

This angle of approach also provides a choice of starting points. Many writers favour the momentous occasion when the Wright brothers first coaxed their 1903 model off the ground and found they had invented the contra-prop, the only disappointing aspect of this otherwise gratifying achievement being that they couldn't write to *Flight* about it.

The First Recorded "Burton"

Others, feeling a longer journalistic runway is required, begin with a mediæval Wop called Leonardo da Vinci, who dabbled with almost everything but never seems to have got down to actual production, no doubt owing to the comparative scarcity of machine tools at that time.

But to carry the idea to its furthermost limits, one starts with the story about a positively pre-historic Johnny named Icarus, who had no more sense than to use wax as a dope for his wing fabric when making an experimental take-off from the top floor of a local skyscraper. He was so long studying his flight plan that one of his erks got tired of waiting and yanked the chocks away in a sudden fit of impatience, at the same time butting his boss in the rudder. Unfortunately the sun had melted the wing dope, and the resultant loss of lift put Icarus into a glide, the steep angle of which could not be materially reduced even by adjusting the incidence to its maximum. Thus launched into space in an unairworthy condition, Icarus hit the deck at high velocity and went for the first burton on record.



—forcibly projecting them before the pilot is quite ready.

Origin of the Catapult Launch

Nevertheless, posterity owes much to this untoward incident, for the impatient erk was none other than Chianti Antonio Titimus Apult (known to his intimates as "Cat" Apult, of course), and ever since that day his name has been applied to the launching of aircraft by forcibly projecting them from a raised platform before the pilot is quite ready.

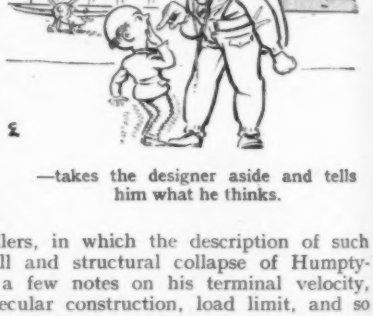
However, Christmas is to be a short holiday this year, so the reader will not want to waste his time by starting so far back in the History of Aviation, and a few observations on strictly modern technique will meet the present need. For the benefit of the complete tyro it may be well to outline briefly one or two essential aspects of the business.

Back Room Boys

Most aircraft nowadays are made of metal instead of wood and fabric. This is because it is much heavier, costs more, and enables the people who produce them to be terribly scientific. First of all they are drawn on paper by men known as Designers, who work in playful competition with other men known as Stress-men. The chief idea of a Designer is to make life difficult for the Production Manager by drawing various bits and pieces in such positions that they get in each other's way as much as possible when it comes to the actual building process. The chief attribute in the mental make-up of a good Designer is a lively sense of Good Clean Fun.

But he is materially helped by the Stress-man, who is able, by doing frightfully complicated sums, to tell him which parts of his aircraft will break as soon as it leaves the ground (or sooner) and will aid and abet him in finding still more awkward places for nuts and bolts and rivets.

Stress-men are specially reared from babyhood for their peculiar mission in life by being fed on cube roots instead of arrowroot and by cutting their teeth on rusks shaped like figures and algebraic signs. Special versions of the usual fairy stories are printed for them, as toddlers, in which the description of such legends as the fall and structural collapse of Humpty-Dumpty includes a few notes on his terminal velocity, impact force, molecular construction, load limit, and so forth. But in spite of all this careful preparation, Stress-men suffer in later life from badly bitten finger nails, and turn grey at an early age.



—takes the designer aside and tells him what he thinks.

Why Prints Are Blue

The principal function of the Production Manager is to take a lot of no notice of the Shop Foreman when he brings the blue-prints back into his office and tells him "It can't be done." Shop foremen always know at least a dozen reasons why any given job can't be done, but all the P.M. has to do is to say, in kindly tones: "I told 'em so, Joe, but you'd best have a shot at it and see what you can do." Then the Shop Foreman will grunt, return to his own corner of the factory—and produce a piece of work as perfect as makes no matter.

Another important person in the evolution of any new military type of aircraft is the Gentleman-from-the-Air

Ministry, who turns up when the job is practically finished with a thing in his hand called "Amended Specification," or words to that effect. This means that the Powers-That-Be have changed their minds about something buried deep in the vitals of the machine. When the factory staff have been restored to consciousness, they set about making the few trifling modifications demanded. This entails some slight delay because it necessitates pulling the whole job to bits and building it all over again.

Finally, however, the aircraft is handed over to the Test Pilot, who takes the stick in one hand and his life in the other, and persuades the aircraft to fly. This is where the Stress-man starts biting his finger nails while the Production Manager and the Designer stand on the tarmac chatting with feigned cheerfulness to a group of Directors, to whose care-free hearts no hint of anxiety must be conveyed.

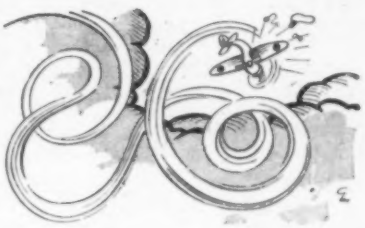
Having contrived to put the aircraft back on the ground in one piece, the Test Pilot takes the Designer aside and tells him what he thinks of the murderous contraption. His opinions are passed on to the Public Relations Dept., who sub-edit them slightly, so that they are issued to the Press as, "I've never flown a better aircraft; she's absolutely perfect."

Development

The Great British Public will read this with intense gratification at breakfast on Monday morning, but will have forgotten all about it by Tuesday. This is just as well, because the next five years will be spent in finding out what is wrong with the confounded thing and how to make it fly properly. This is known as "Development" and, at the end of the period, a machine bearing not the slightest resemblance to the original will Go Into Production—by which time it will, of course, be comfortably out of date, and can then be sold to the Japanese.

Well, having built a lot of aircraft, it is also necessary to teach people how to fly them. For this thankless task there are unsung heroes known as Flying Instructors—grim-faced men with no illusions, but oodles of patience. Fortunately for the pupil, the aircraft used for this purpose has what are known as Dual Controls—one set in your cockpit and one in the Instructor's. These look exactly the same, but you soon find out they are not.

Once in the air, the Instructor shows you how to "Keep her straight and level," and then he suddenly makes the terrifying statement that "You've got her," and, with eye fixed grimly on the horizon, you try to imitate his performance. This is where you find out that your controls are very different from those in the Instructor's cockpit, because the aircraft immediately begins to lurch about all over the sky. However, the wretched things work better in time, after which you learn to put the machine back on the ground. This would be quite simple if only the airfield would treat you with the same sense of fair play it accords to the Instructor. But it does nothing of the kind, of course.



—begins to lurch about all over the sky.

Just as you are congratulating yourself on having made quite a good approach, you find that the field is retreating in front of you and the boundary fence is apparently making a determined effort to climb over the aircraft instead of sliding obediently under its wheels. Then, when sheer panic is freezing you solid, the engine roars out, the stick twitches in your clammy hand, and the aircraft lifts and surges happily over the homicidal fence.

"Come, come," says the Instructor's calm voice, "couldn't you see you were undershooting!"

Burning with shame, you are permitted to try again—and so on, until the airfield gets to know you and consents to keep still while you land on it.

Much more remains to be told, but it will have to wait till next Christmas.

Good Advice, But Too Late

HUMOUR crops up in the most unlikely places, especially the accidental variety!

You would not, for example, expect to find anything particularly amusing in a sober publication like the Civil Aeronautics Journal, issued twice monthly by the Civil Aeronautics Administration of the U.S. Department of Commerce, and but for the "Keep 'em flying" slogan now so popular in America, the prosaic character of this journal might never have been relieved.

In the October 15th issue, however, this useful little slogan, which is dropped in a couple of times in every issue where there's room at the bottom of a column, appears in an all too appropriate spot—it has been inserted immediately below an accident report!

(*Canadian Air Cadet*)

"Don't you think Montgomerie is a little too enthusiastic?"

—Ad Astra

First Pilot: "It makes me cross to be told I haven't enough altitude."

Second Pilot: "It makes me soar, too."

—None So Blind . . .

M.O.: "Weak eyes, eh? How many lines can you read on that chart?"

Draftee: "What chart?"

Xmas Interlude

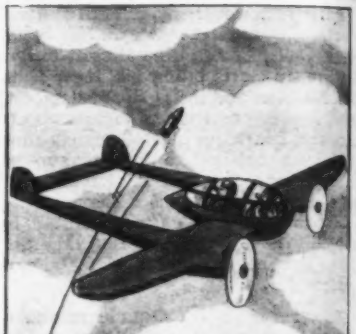
CONTINENTAL COMEDY

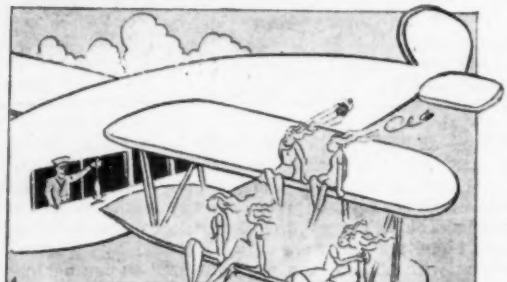
Even "Jerry" Can See the Funny Side of Things

These Humorous Sketches are Selected from German Aviation Journals.

(Left) "Are you an airman, too?" "Heck, no, I'm a motor cyclist."

(Right) "Now you see the idea of the double fuselage."





"You can come back now, ladies; we've caught the mouse."

"Next time I'll bring a machine gun!"

Acting Rank!

"Just fancy that," exclaimed the proud mother. "They've promoted our Herbert for hitting the sergeant. They've made him a court martial."

Dismay Down Under

First Kangaroo: "Where is the baby?"

Second Kangaroo: "My goodness, I've had my pocket picked."

He Must Have Had a Bicycle!

Feudal Lord: "I hear you misbehaved while I was away, son."

Knight: "In what manor, sir?"

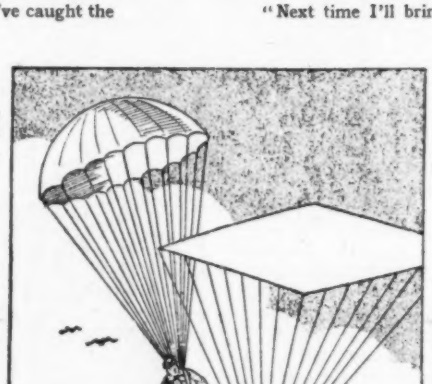
The Lesser Evil

Three Canadian aircrew, sleeping in a tent in one of the English training areas last summer, were rudely awakened by a terrific crash not far away.

"What was that—thunder or bombs?" asked one.

"Bombs," was the laconic answer.

"Thank heaven for that!" chimed in the third. "I thought we were going to have more rain!"



"Who the dickens told me to starch and iron this blinking parachute?"

And She Could

R.A.F.: "Can you read my mind?"

W.A.A.F.: "Yes."

R.A.F.: "Go ahead."

W.A.A.F.: "No, you go ahead."

Oh hElf!

My tYpist is on her vacation
My typist's awau fpr a week
My typudt us in her vscarion,
Wgile thsee damb keys plsy hude and seej.

Gosh, That Was Tough!

Once upon a time there was an Aged Journalist and he was telling a Youth of the old hard times in his trade when salaries were not and wages were not very either. "In those days, my boy, we used to send messages by pigeon. Alas, my pigeon never reached the office." "And why was that, sir?" asked the youth. "I ate it!" replied the old one simply.

Newspaper World.

•

Bouquet From U.S.A.

A gangster rushed into a saloon shooting right and left, yelling, "All you dirty skunks get outta here."

The customers fled in a hail of bullets—all except an Englishman, who stood at the bar calmly finishing his drink. "Well?" snapped the gangster, waving his smoking gun.

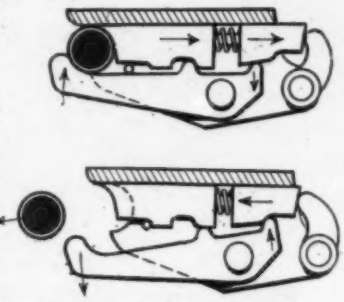
"Well," remarked the Englishman, "There certainly were a lot of them, weren't there!"

POSITIVE LOCKING

A Device Which is of Special Interest for Aircraft Gun Mountings, but with Many Other Applications

THERE are in an aircraft a great number of parts which have to be readily detachable but the locking of which must also be absolutely positive. In the days when folding wings were more common than they are now, the locking pins in the leading edge were a case in point. There have been, we believe, several instances of accidents caused by the failure to lock the bolts properly before take-off.

In modern aircraft, wing folding is rarely seen outside the Fleet Air Arm, but there are many other uses for positive self-locking devices. Such items as retractable undercarriages, bomb-release gear, jettison hinges and gun mountings are a few examples which come to mind instantly. A device has been introduced by a British firm recently which should find very many applications in the aircraft industry.



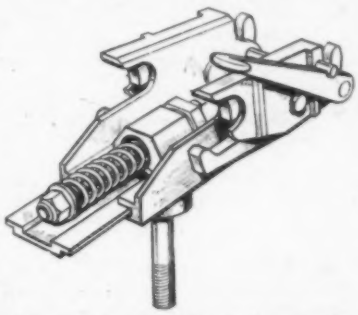
The "S-L" self-locking device in the locked and open positions. The black circle represents one of the trunnions of an aircraft machine gun.

Known as the "S-L" automatic locking device, it is the product of Self-Locking Mechanisms, Ltd., and in the form shown in our sketches it is applied to the mounting of an aircraft machine gun. In addition to the self-locking feature the device also incorporates a gun-recoil spring which has been found to relieve the aircraft structure of shock loads, not to mention that a substantial increase in the rate of fire was obtained. It was even found that a man could comfortably hold the assembly while the machine gun was being fired.

To deal with the self-locking device first: this comprises a gunmetal saddle in which are incorporated two automatic locking units. From the sketches it will be seen that each of these units has a double cam and a two-stage cam follower or slide. The upper sketch of the locking mechanism shows the member to be secured in the locked position. The claws of the hinged cam member hold the part securely, being prevented from opening by the two cams. A release lever having a curved trigger serves to open the jaws. Depression of the lever forces the front part of the cam slide back and compresses the spring. The shape of the slide is such that when it has moved back a short distance the cam is free to rise slightly and in doing so permits the claw to drop. The pressure of the release lever, and of the spring between the two slides, forces the second slide back, thus opening the claws wide and ejecting the member to be released.

Our perspective sketch shows the locking device applied to a machine-gun mounting. The claw can be seen just to the right of the threaded mounting bolt, and the end of the rear cam slide is seen projecting through the casing. The trunnions of the gun are held between these two.

The recoil part of the mechanism comprises the main support of the cam assembly, working in a slide, an adjustable spring which controls the amount of travel of the gun, and a rubber buffer which takes the shock when the gun returns to its forward position.



The "S-L" self-locking device applied to a non-recoil machine gun mounting.

An interesting feature of the gun-mounting unit is the ease with which the gun can be shipped and unshipped. After the gun has been taken off the aircraft for cleaning, etc., or has been temporarily removed from its mounting, it is re-mounted instantly merely by offering it up to the open jaws, which snap shut as soon as pressure is applied by pushing the gun forward.

Particulars of other models of the "S-L" automatic self-locking device may be obtained from Self-Locking Mechanisms, Ltd., whose offices are at Grand Buildings, Trafalgar Square, London, W.C.2.

New American Trainers

FOLLOWING the assurance given by Maj. Gen. Arnold some months ago, that there would be enough trained pilots to man the Air Corps' bombers under the "500-bombers-a-month" programme, our contemporary, *American Aviation*, gives details of two new advanced training types which have just been delivered. Known as the AT-9 and the AT-11, the two new types were designed and built by the Curtiss-Wright Corporation's St. Louis factory and the Beech Aircraft Corporation, Wichita, Kansas, respectively. Both are all-metal low-wing monoplanes with retractable undercarriage.

"The Curtiss AT-9," our contemporary states, "with a top speed of more than 200 m.p.h., accommodates a crew of two but has provision for four, and incorporates the performance and operating characteristics of larger multi-engined tactical craft, including numerous instruments. It will be manufactured in 'large numbers' in the nearly completed Curtiss-Wright plant at Lambert Field, St. Louis.

"The Beech AT-11 will be used for specialised training of bombardiers and gunners. It is equipped with flexible guns and bomb racks for the instruction of a crew of three or four men, depending upon the instructional mission. Power is delivered by nine-cylinder, 450 h.p. Pratt and Whitney engines."

The Airscrew Shortage

FROM the same source we learn that a certain amount of criticism has been levelled at American airscrew manufacturers, mainly the Curtiss-Wright Propeller Division, complaining that aircraft have been held up in large numbers while waiting for airscrews. It is explained that the company had a difficult task to tackle, and that at first the hollow-steel airscrew had to be made in small quantities, as the orders did not justify the laying down of a large plant with quantity-production machinery. Now, however, this has been remedied, and the firm has received Government assistance in the form of machine tool priorities, so that before long the output of hollow-steel blades should catch up with requirements.

Reference is also made to a new steel airscrew which, like the Curtiss, is to have a hollow hub through which an aircraft cannon can be fired. This new blade comes from the Aero-products Division of General Motors and may be offered for service on the Bell Airacobra as an alternative to the Curtiss. Four-bladers are said to be in production for the Martin B-26 medium bomber and the Republic P-47 Thunderbolt fighter.

An American newspaper story stated some time ago that 245 Bell Airacobras were ready for delivery except for airscrews and machine guns. It has now been officially denied that 40 Airacobras had been held up by the airscrew shortage.

HERE AND THERE

Fighter-Pilot Artist

THE West Riding of Yorkshire squadron of Fighter Command is rapidly collecting its own portrait gallery. The artist is a 20-year-old fighter pilot in the squadron. Paintings by him were exhibited in the Royal Academy in 1938 and 1939.

He recently showed paintings in the art exhibition held at station headquarters. His pictures were hung alongside works by Augustus John, Walter Sickert, and other prominent artists.

The pilot was educated at Repton and the Royal Academy School, joined the R.A.F.V.R. on the outbreak of war, won his wings in Rhodesia under the Southern Rhodesian Training Scheme, and has flown in sweeps over France.

Cans and Cabbages

THERE is a station of Technical Training Command, R.A.F., at which there is a school of instruction for craftsmen in metal work.

The officers' mess of that station has probably the finest set of beer tankards in the whole of Great Britain. Every one of those handsome "cans" was made in spare time in the metal workers' school.

This is just an instance of the self-contained efficiency of the R.A.F. There is scarcely anything which this station does not provide for itself; in fact, during this year, it grew 70 tons of potatoes and 60,000 cabbages on ground between the camp hutments.

Lunch to Sir F. Shelmerdine

MEMBERS of the Guild of Air Pilots and Air Navigators of the British Empire recently gave an informal lunch to Lt. Col. Sir Francis Shelmerdine, the retiring Director-General of Civil Aviation at the Royal Air Force Club.

Those present included Capt. P. D. Acland, Mr. W. Austin Balls, Sir Alan Cobham, Sqn. Ldr. A. M. Diamant, Capt. O. P. Jones, Capt. A. G. Lamplugh, Wing Cdr. C. A. Pike, Sqn. Ldr. R. C. Preston, F/O. R. J. B. Pearse, Flt. Lt. H. A. Roxburgh, Sqn. Ldr. E. H. D. Spence, Sqn. Ldr. R. H. Stocken, Sqn. Ldr. N. H. Woodhead and Mr. L. A. Wingfield

It was announced that Mr. Peter Reid, decd., a former Commander of British Airways and a number of the Guild, had left £100 to the Benevolent Fund, and his navigational instruments and sextant to the Guild.

Radio Men Wanted

THERE is an urgent need for civilian radio operators at ground stations in this country where modern radio equipment is being used for work of national importance, including essential life-saving services. This work is not only of absorbing interest in itself, but in addition it provides practical experience which should be of great value in post-war days when flying for business or pleasure will surely be within the reach of nearly everyone and will call for the provision of radio ground services on an extensive scale.

Any qualified man who is interested in this work can obtain further information from the Under-Secretary of State, Air Ministry, 37, Julian Road, Bristol, 9.

ON THE ICE: A refrigerator at the Douglas Aircraft works where the effects of low temperatures and rare air on crews and instruments can be studied. A temperature of 104 degrees below zero can be attained.

R.A.F. Gramophone Records

IN order to make R.A.F. service music available to stations, large or small, in all parts of the world, a set of special H.M.V. recordings by R.A.F. personnel has just been issued.

Bands, which have been touring R.A.F. stations in the various commands, include a great many of peacetime's leading musicians, a number of whom are in the R.A.F. Central Band and Orchestra, which has recorded the programme, and this is the first set of official recordings of its kind made by any of the Services.

The set comprises ten records grouped under three headings: Ceremonial, Programme for a Guest Night, and Sunday Evening—the first of the three groups including "Trumpet Calls of the R.A.F." and other essentially R.A.F. music. R.A.F. choruses are also among the "guest night" selection.

It was felt that remotely situated detachments, R.A.F. units in training overseas and units of the A.T.C., none of whom are within the reach of the R.A.F. bands, will welcome these records. All profits from their sale are to go to the R.A.F. Benevolent Fund.

Active Service Badges

"CANADA" badges worn on the shoulders of members of the Royal Canadian Air Force will remain solely the distinguishing mark of personnel who have served in an active theatre of war or those who are under orders for overseas service, Royal Canadian Air Force Headquarters has announced.

The unconditional nature of enlistment in the R.C.A.F. eliminates any necessity—as in the case of the Army—of distinguishing between those who have volunteered for service overseas and those who are engaged in service in Canada alone. All members of the R.C.A.F. have volunteered to serve the King anywhere in the world, and the special shoulder badges become necessary only to identify Canadians serving along with other Empire forces in some theatre of action.

Recently the Army decided to provide "Canada" badges for all personnel volunteering for overseas service to distinguish them from those engaged solely in home defence.

New "Flight" Chart

A NEW and revised edition of the *Flight* Identification Chart of British Aircraft is now on sale. Grouped according to type (fighters, bombers, flying boats, and advanced trainers), and with Fleet Air Arm aircraft marked "Fleet" in red, the perspective illustrations present a general air aspect of each aircraft.

Excepting the trainers, these perspectives are accompanied by line drawings depicting side elevation, head-on and plan views. Particular characteristics also are mentioned in adjacent text. Twenty-six leading types of aircraft are included on the latest chart, which embodies nearly 100 illustrations in all.

Copies may be obtained from *Flight* Offices, Dorset House, Stamford Street, S.E.1, price 1s. 3d. each, postage 6d. extra for single copies, 7d. up to three copies and 8d. up to six copies, and through booksellers and newsagents.

Save That Paper!

WHEN you are eagerly unwrapping your Xmas presents, remember that the paper around every parcel is even more valuable to the country than are its contents to you—and salvage it!

JAPAN IN THE AIR

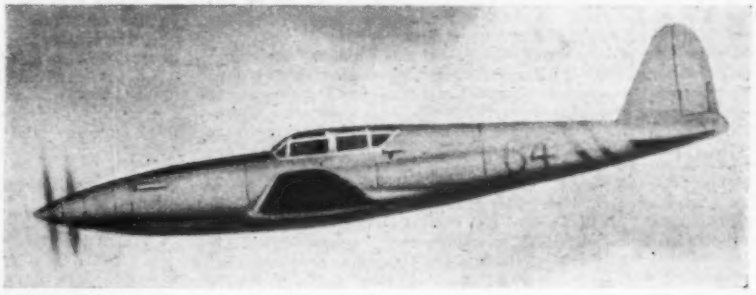
Her Aircraft Industry: 15 Aircraft Works and 9 Engine Factories: Some New Fighter Types

FROM previous articles in *Flight* our readers will know that there is no independent Japanese air force, but that the army and navy each has its own air arm. They will also have some idea of the types of aircraft likely to be still in service, although information concerning recent developments has been difficult to obtain. From German sources we have succeeded in digging out the following facts and views, which are of interest in helping to indicate modern trends and tendencies.

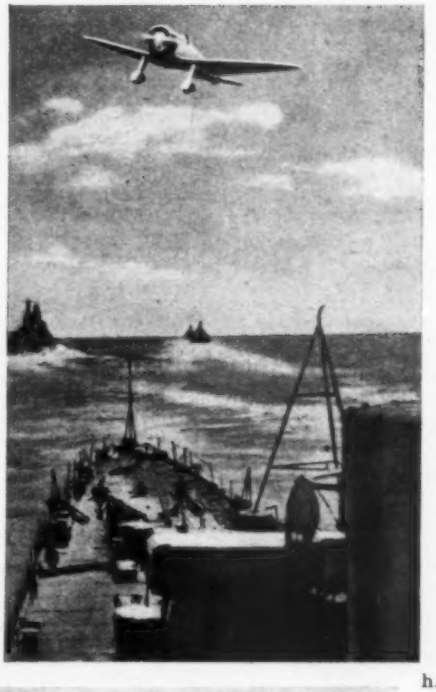
As mentioned in a previous article, Japan has mainly relied for her licence-built types on German, Italian and to a smaller extent American designers. Japanese air missions have spent much time in Germany, and as a result the following German types are now in service: In the Japanese army, the Junkers Ju 86 and 87, and the Heinkel 111 and 112. Italy is represented by Fiat C.R.42 fighters, and B.R.20 bombers. In addition the army has some Koolhoven F.K.58 fighters. Of American types mention must be made of the North American N.A.16 reconnaissance monoplane and the Lockheed 14. The rest of the equipment is of Japanese design, much of it based upon foreign prototypes.

The Japanese navy appears to have relied less on foreign and more on home-produced designs than the army. The rivalry between the two services has no doubt played a part in bringing about this distinction. The German source from which we quote estimates that the combined air strengths of the two services is in the neighbourhood of 3,000 aircraft. That statement was published last July, so that our own estimate, published last week, of 3,800 aircraft seems to have been fairly accurate.

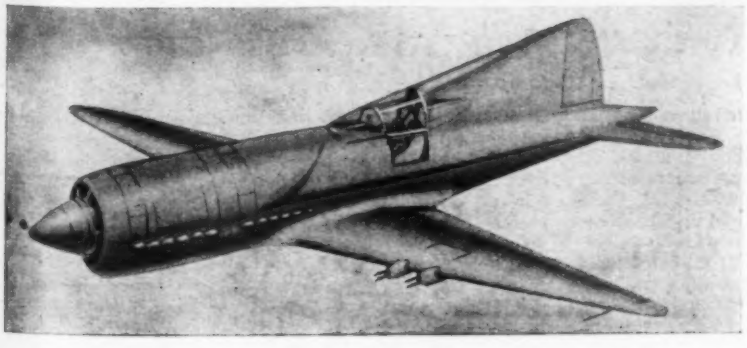
To show the possible trend of modern Japanese design we publish drawings of two fighters. There is no confirmation that they have gone into service, but they do seem to indicate the lines on which Japanese designers are thinking. Both are twin-engined (tandem) types, with contra-rotating airscrews, but the layout differs according to the engine type. In the A.T.27 the pilot sits between the two steam-cooled V-12 engines of 1,250 h.p. each. It is claimed that in this position not only is the pilot on the centre of gravity, and, therefore, subjected to a minimum of acceleration, but that he is protected front and back by his engines, or alternatively two armour plates could be used as protection for pilot and engines alike. The wing area of the A.T.27 is given as 237 sq. ft. and the empty weight as 8,000lb. With a disposable load of 3,600lb. the all-up weight becomes 11,600lb., which would give a wing loading of 49 lb./sq.ft.! A range of 1,250 miles is claimed, and the top speed is said to be 410 m.p.h.



In the A.T.27 the pilot sits between two steam-cooled V-12 engines of 1,250 h.p. each.



(Right) A Mitsubishi 96 co-operating with the Japanese Navy. (Below) The Suzukaze 20, which is said to have two air-cooled radials in tandem. The exhaust stubs do not appear to bear out this statement. A speed of 478 m.p.h. is claimed, but appears very unlikely.



The other new fighter design, the Suzukaze 20, is based on two radial air-cooled engines of 1,200 h.p. each. The short length of the radials has made it possible to keep the pilot behind the engines in a position somewhat reminiscent of the American Gee-Bee racer. It is a much smaller machine than the A.T.27, with a wing area of 144 sq. ft., a loaded weight of 6,300lb., a wing loading of 44 lb./sq. ft., and a claimed top speed of 478 m.p.h.

Other new fighter designs of more orthodox conception are the T.K.4 and the T.K.19, the former a twin-engined twin-tail monoplane and the latter a single-engined machine of

(Continued at foot of next page.)

Correspondence

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

RANGE AND FUEL ECONOMY

Conditions for Maximum Distance

MR. HININGS' statement, in his article on Range and Fuel Economy, to the effect that maximum range is *not* obtained at maximum L/D ratio, is somewhat difficult to reconcile with the following simple argument:—

Petrol is liquid energy; energy is the capacity for doing work; work is force×distance; the force required is equal to the drag of the aircraft. Since the lift is fixed, being equal to the weight, the drag is least when L/D is greatest. Therefore, for a given distance, maximum L/D corresponds to least work, which means least petrol. The less petrol you use per mile, the further you can go per gallon.

There are, of course, complications due to airscrew efficiency and engine economy, and Mr. Hinings may have been thinking of these, though he does not say so, and the fact that he goes on to say that "H.P. required at . . . maximum L/D ratio is the minimum to sustain level flight" suggests that he does not mean to say so.

Power, they say, is force×velocity; if so, it can easily be shown that the power required for level flight varies inversely as $C_L^{3/2}/C_D$; this is, of course, not the same as either $L^{3/2}/D$ or L/D.

W. E. HICK.

CAMERA CURIOSITY

Relation of Airscrew and Shutter Speeds

THE query of puzzled schoolboy in *Flight* of December 4th regarding the above interests me, as I have observed the peculiarity myself for some years.

I humbly venture to offer my theory regarding this strange similiarity in airscrew position.

Briefly, the phenomenon is dependent upon the relationship of airscrew speed/camera speed.

Choosing an engine speed of 2,800 r.p.m., which is 46.666 r.p. sec., then, ignoring any reduction gearing, the airscrew must rotate 46.666 r.p. sec. also.

Thus:

For one-bladed airscrew, blade passes any point in its swept circle 46.666 times per second.

For two-bladed airscrew, a blade passes 93.332 times per second.

For three-bladed airscrew, a blade passes 139.998 times per second.

For four-bladed airscrew, a blade passes 186.664 times per second.

In the case of the three-bladed airscrew, a blade is seen across the line of sight 139 998 (use 140) times per second.

Assuming a camera shutter speed of 1/100th sec., then whilst shutter is open an airscrew blade must come into view *at least once* (actually 1.4 times).

In view of the fact that a blade is most clearly discernable when viewed "broadside on," then whilst the shutter is open the blade is bound to record itself upon the film or plate.

Sometimes the airscrews appear in the horizontal position; in fact, in any common position—this position being entirely dependent upon the position from which the photograph is taken.

For a two-bladed airscrew, both blades are clearly seen, whereas for a three-blader, one blade is clear but the other two are indistinct.

In the case of four blades, I should imagine that two opposite blades are clearly seen (like the two-blader).

As for our old friend, the "contra-prop"—heaven only knows!!

I would appreciate the furious comments upon this effort of mine from my fellow-readers.

NORMAN S. ASTON.

CONTRA-ROTATING AIRSCREWS

Torque Effect in Differing Designs

THE writer has read the recent opinions in regard to the torque from contra-rotating airscrews with considerable interest. The situation is actually somewhat less simple than some of your correspondents indicate.

As the engineer responsible for the design policy actually pursued in one of the best-known types, it was necessary for the writer to undertake a complete investigation of the principles to be used.

When this was being done, many of the propositions put forward by your correspondents came up for examination and several very attractive-looking fallacies were eliminated.

In general, if an engine has one airscrew mounted on it, then the airscrew reacts on the air, the air reacts on the aircraft, the aircraft reacts on the engine and the engine reacts on the airscrew, thus completing a torque circuit.

If the engine has two airscrews mounted on it rotating in opposite directions, then two torque circuits are established, and the algebraic sum of the torques at any one point must be checked to see what the actual torque exerted at that point amounts to.

If the engine drives the two airscrews through a differential gear, then the torques exerted by the two airscrews on the air will be equal and opposite, and hence the torque exerted by the air on the aircraft will be zero, and this will continue to be the case even though there is a large difference in speed between the two airscrews.

If both airscrews are positively driven at equal speeds, or in a fixed-speed ratio, then the torques exerted by the airscrews on the air are not necessarily equal and the torque exerted by the air on the aircraft will be equal to the difference between the two airscrew torques.

It is for the designer to decide which system is preferred to suit any given pitch-changing mechanism and set of circumstances.

War conditions make it undesirable to explain the actual choice which has been made, but when normal times come round again and such matters become generally known and studied it will be found that the system selected for the present types is the right one for the actual conditions met with at the present time.

H. N. CHARLES.

JAPAN IN THE AIR

(Concluded from page 469)

orthodox outward appearance, but with the twin row radial placed some way back in the fuselage and cooled by a duct system not unlike that of the De Havilland Albatross.

According to our German source, Japan recently had fifteen aircraft factories and nine engine works. These are said to very up-to-date in their planning and organisation, and to be equipped with the very latest machinery. The most important works are said to be the following (their products being shown in parentheses after the name):—Ishkawajima (reconnaissance aircraft and engines); Kawanishi (seaplanes and flying boats); Kawasaki (fighters, bombers and engines); Nakajima (aircraft engines and military aircraft of all classes); Mitsubishi (fighters and engines). The latter firm has four large works. These are the older firms. Among the new may be mentioned Hitashi (aircraft and engines); Watanabe (landplanes and seaplanes); Masada (aircraft); Nishii (Italo-Japanese undertaking for the production of Fiat aircraft); Nippon (seaplanes); and Showa (aircraft).

The German writer does not appear too well informed. For example, he fails to indicate that Mitsubishi also build bombers.

STRAIN ENERGY

Some Introductory Notes and Examples for Students

By H. PARKINSON, A.F.R.Ae.S.

THE complete or *firm* structure is one with just sufficient members to keep it rigid under any well-defined system of external loading, and the forces in the individual members may be directly found by any of the methods usually applied to statically determinate structures.

When the number of members is in excess of that required for the firm structure it is statically indeterminate, or redundant, and *strain energy* is a method used for solving the various forces. Other variations of the subject title are *Elastic Strain Energy* or the *Theorem of Least Work*, the latter being a description of Castigliano's second theorem.

Due to the redundancy of the aircraft structure, under the varying conditions of external loading, it is necessary to trace the forces in the alternative load paths for two purposes. The first is to determine the maximum forces in the structural members when the sizes are known, the second to use to the fullest extent in design members primarily introduced to meet a particular form of loading.

In the first case, the presence of redundant members may give rise to an increase or decrease of certain forces estimated on the basis of a firm frame. A simple example of this is shown later. In the second case, consideration of all available members may help in the direction of minimum structural weight when the size can be modified by progressive trial and error.

Definition of Strain Energy

If any member be stressed within the elastic limit a certain elongation (or contraction) will become apparent, and on removal of the load producing the stress the member will return to the original length. We see then that a certain amount of work is expended in producing the elongation, and it is evident that this work must be stored in the elongated member in a form of potential energy

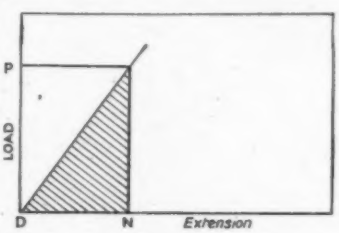


Fig. 1.

Referring to Fig. 1, if the member be elongated by the amount DN, within the limit of proportionality under the action of load P, then the work done is represented by the shaded area.

If, P = load
e = elongation
and w = work done

$$w = \frac{Pe}{2}$$

This is the quantity known as strain energy.

Let W = total work done on the structure
$w_1, w_2, w_3 \ldots$ = work done on each member.
Then $W = w_1 + w_2 + w_3 \ldots$

It should be noted that the basis of the foregoing is the law of proportionality between stress and strain, and as such it only holds good within the elastic limit. For stresses beyond the elastic limit a certain amount of the work done on the member is expended on producing the permanent set and cannot be recovered.

Theorem of Least Work

When the disposition and number of members is such that the forces may be taken in more than one way, this theorem provides that the total work (W) done on the structure is a minimum.

Data Required for stressing.—In addition to the structure diagram and external loading we see from the foregoing that the cross-sectional area, and material, of the members must be known beforehand. In view of this it is necessary to make some provisional estimates, the final size being fixed on a basis of trial and error.

Example 1—We are required to find the loads in each of the tubes illustrated in Fig. 2. The tubes, are of equal length and cross-sectional area, the centre tube being of steel and the two outers of dural. The load is applied concentrically with the centre tube, and the link plates are assumed to have no deflection under load.

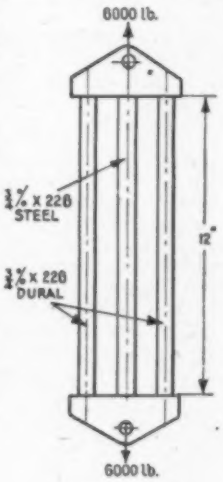


Fig. 2.

E for steel = 30×10^6 lb./sq. in.
E for dural = 10.5×10^6 lb./sq. in.

As there is no deflection in the link plates, the elongations of all the tubes are numerically equal.

Let P = Load in any one tube
L = Length
A = Cross-sectional area
e = Elongation.

We have, stress $= \frac{P}{A}$

strain $= \frac{e}{L}$

and $E = \frac{\text{stress}}{\text{strain}} = \frac{PL}{Ae}$ or $e = \frac{PL}{AE}$

If P_D = load in each dural tube
P_S = load in steel tube
E_D = E for dural
E_S = E for steel

Then $\frac{P_D L}{AE_D} = \frac{P_S L}{AE_S}$

and $2P_D + P_S = 6{,}000$ lb. (applied load)
or $P_S = 6{,}000 - 2P_D$.

From the definition of strain energy

$$w = \frac{Pe}{2}$$

Therefore, work done by *both* dural tubes

$$= 2\left(\frac{P_D}{2} \times \frac{P_D L}{AE_D}\right)$$

$$= \frac{P_D^2 L}{AE_D}$$

Work done by steel tube $= \frac{P_S}{2} \times \frac{P_S L}{AE_S} = \frac{P_S^2 L}{2AE_S}$

As $P_S = 6{,}000 - 2P_D$

STRAIN ENERGY

$$W \text{ (total work done)} = \frac{P_D^2 L}{AE_D} + \frac{(6000 - 2P_D)^2 L}{2AE_S}$$

Substituting known values

$$W = \frac{P_D^2 \times 12}{.064 \times 10.5 \times 10^6} + \frac{(6000 - 2P_D)^2 \times 12}{2 \times .064 \times 30 \times 10^6}$$

$$= .00001785 P_D^2 + .00000312(36{,}000{,}000 - 24{,}000 P_D + 4P_D^2)$$

$$= .00001785 P_D^2 + 112.5 - .0748 P_D - .00001248 P_D^2$$

$$W = .00003033 P_D^2 + 112.5 - .0748 P_D.$$

From the theorem of least work we know that W must be a minimum, so that it is necessary to find the value of P_D which will satisfy this requirement. Values for P_D are assumed and W is found from the above expression, this work being tabulated below.

P_D	1,000	1,100	1,200	1,300	1,400
W	68	66.7	66.3	66.5	67

These quantities are plotted in Fig. 3, from which it is seen that W is a minimum when,

$P_D = 1235$ lb.

Therefore,

$P_S = 6000 - (2 \times 1235) = 3{,}530$ lb.

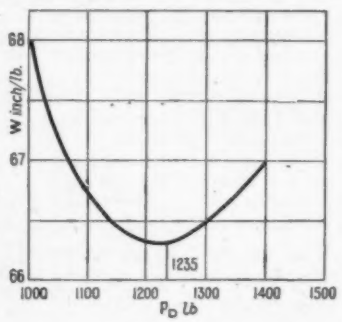


Fig. 3.

The work involved in constructing Fig. 3 can be eliminated by simple differentiation of the expression,

$$W = .00003033 P_D^2 + 112.5 - .0748 P_D$$

As W will be a minimum when,

$$\frac{dW}{dP_D} = 0$$

$$.00006066 P_D - .0748 = 0$$

$$P_D = \frac{.0748}{.00006066} = 1{,}235 \text{ lb.}$$

This particular example can also be solved as follows:

$$\frac{P_D L}{AE_D} = \frac{P_S L}{AE_S}$$

$$\frac{P_D L}{AE_D} = \frac{(6000 - 2P_D)L}{AE_S}$$

$$\frac{P_D}{E_D} = \frac{(6000 - 2P_D)}{E_S}$$

$$\frac{30 \times 10^6 P_D}{10.5 \times 10^6} = 6000 - 2P_D$$

$$4.86 P_D = 6000. \quad P_D = 1235 \text{ lb.}$$

Example 2.—To find the forces in the redundant pin-jointed frame shown in Fig. 4, the procedure is as follows.

A redundant member is selected, in this case CB, and the forces in it are represented by F. Expressions are now found for the forces in AD and CD in terms of the applied load of 500 lb. and the force F, these being obtained by the ordinary triangle of forces. The lengths of the members are also determined, this information being tabulated thus:

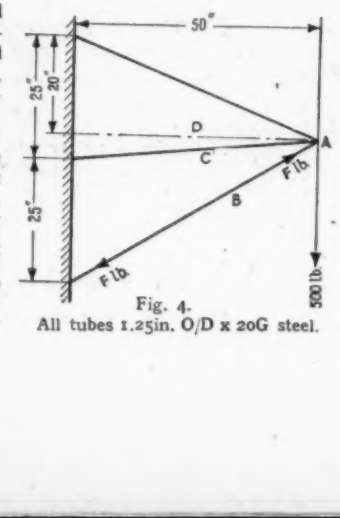


Fig. 4.
All tubes 1.25in. O/D x 20G steel.

Member	Force due to F	Force due to 500 lb.	Total Force	Length of Member
AD	+.92F	− 1070	+.92F − 1070	53.9"
DC	−1.72F	+1000 lb.	−1.72F+1000	50.25"
BC	—	F	F	58.3"

Minus sign denotes tensile force. Plus sign compressive force.

Let P = force in member

Then work done on each member $= \frac{P^2 L}{2AE}$

Work done on AD

$$= \frac{1}{2AE}(+ .92F - 1070)^2 \times 53.9$$

$$= \frac{1}{2AE}(.846F^2 - 1970F + 1145000)53.9$$

$$= \frac{1}{2AE}(45.6F^2 - 106000F + 61700000)$$

Work done on DC

$$= \frac{1}{2AE}(1000 - 1.72F)^2 \times 50.25$$

$$= \frac{1}{2AE}(1000000 - 3440F + 2.96F^2) \times 50.25$$

$$= \frac{1}{2AE}(50250000 - 173000F + 149F^2)$$

Work done on BC $= \frac{1}{2AE}(58.3F^2)$

Total work done on frame = W

$$W = \frac{1}{2AE}(45.6F^2 - 106000F + 61700000) + \frac{1}{2AE}(50250000 - 173000F + 149F^2) + \frac{1}{2AE}(58.3F^2)$$

$$W = \frac{1}{2AE}(252.9F^2 - 279000F + 111950000)$$

As illustrated in the previous example, a number of values should be assumed for F (P_D in previous example) and the corresponding values of W found from the above expression. A graph of F against W is then plotted and the lowest value of W read off to find F

Completing the remainder of the work by simple differentiation.

W is a minimum when

$$\frac{dW}{dF} = 0$$

$$\frac{dW}{dF} = \frac{1}{2AE}(505.8F - 279000)$$

$$\frac{1}{2AE}(505.8F) = \frac{1}{2AE}(279000)$$

$$F = \frac{279000}{505.8} = + 553 \text{ lb.}$$

F = Force in B.C. = + 553 lb.
Force in AD = .92F − 1070 = − 562 lb.
Force in DC = 1000 − 1.72F = + 50 lb.

Example 3.—A simple comparison between the forces in a redundant frame and the equivalent firm frame is given by use of the previous example.

Suppose the member DC be removed from Fig. 4 and the same condition of loading be applied (Fig. 5).

The forces in the firm frame are:

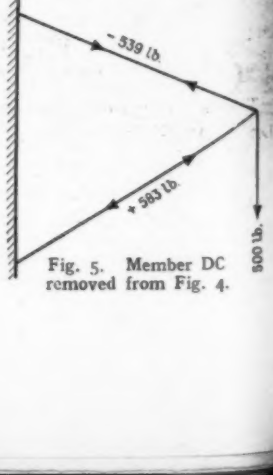


Fig. 5. Member DC removed from Fig. 4.

Top member — 539 lb.
Bottom member + 583 lb.

In the redundant frame:

Top member — 562 lb.
Bottom member + 553 lb.

It is seen that the introduction of member DC has the effect of increasing the forces in the top member and decreasing them in the bottom member.

The aircraft structure is, of course, far more complex, but this elementary example serves to illustrate the effect of redundancies.

Returning to Fig. 5, small discrepancies in the lengths of the members will not introduce any difficulties to the operation of assembly, the only effect being a slight modification to the geometry of the frame. If however, a further member (DC in Fig. 4) of incorrect length be added, it will be necessary to deform the frame to facilitate assembly thus introducing initial stresses into the members. Stresses under this heading are algebraically additive to the normal stresses due to the external loads.

It is assured that no initial stresses exist in the frames chosen as the subjects of the examples worked above.

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Strength of Materials, Morley. (Longmans, Green & Co.).
Strength of Materials, Case. (Edward Arnold & Co.).

LENINGRAD

THE worst that Germany could do failed to pierce the defences of Leningrad, shown in the picture below, which is one taken by the *Luftwaffe*. The city was founded by Peter the Great, who visited England in 1698 and took back with him to Russia some 500 engineers and skilled artisans. When war with Germany broke out in 1914 the name of the city was Russianised into Petrograd, and after the revolution it was changed to the present Leningrad.

It will be noted from the photograph that the city is laid out in a modern manner, and that the rivers and numerous canals turn it into a collection of islands. This was of great advantage in the old days, but is of less importance against air attack. The canals and rivers are lined with grey and pink granite embankments. Features of special note are numbered on the picture and explained in the inscription.

1, The Peter and Paul fortress, with the golden-spired church of St. Peter and Paul behind it. 2, The arsenal. Opposite, on the south bank of the Neva, is 3, the Winter Palace, residence of the former Tzars. Near this is the Hermitage, the world-famous art gallery, built by Catherine II. 4, Dekabrist Square, with the magnificent equestrian statue of Peter the Great. 5, The imposing Church of St. Isaac of Dalmatia. 6, The Prospect of 25th of October, formerly the famous Nevsky Prospect, in which stands, 7, the Alexander Theatre. 8 is the main railway terminus for Moscow, and 9 the terminus for the railway to Finland. 10 is the Nevka River and 11 the Neva. 12 is a suburb of Leningrad, called Viborg.

Service Aviation

Hurricanes lined up on an Icelandic aerodrome.

Royal Air Force and Fleet Air Arm News and Announcements

Awards

THE KING has been graciously pleased to approve the following awards in recognition of gallantry displayed in flying operations against the enemy:—

DISTINGUISHED SERVICE ORDER.

Wing Cdr. R. G. YAXLEY, M.C., D.F.C., No. 272 Squadron.—Since the operations in the Western Desert commenced this officer has led his squadron with conspicuous success. Enemy airdromes, as far west as the battle area as Benghazi, have been attacked daily and other serious damage has been inflicted on the enemy. On the opening day of the operations a number of Junkers 52 aircraft carrying troops were encountered and seven of them were shot down.

In addition to a daily toll of enemy aircraft destroyed, heavy casualties have been inflicted on ground crews, while lines of communication have been harassed and petrol tankers set on fire. Altogether, within a space of six days' operations, no fewer than 46 of the enemy's aircraft were destroyed. Much of the brilliant success achieved can be attributed to the courageous leadership and determination displayed by Wing Cdr. Yaxley. Throughout he has set a magnificent example.

Sqn. Ldr. D. E. GILLAM, D.F.C., A.F.C., R.A.F.O., No. 615 Squadron.—This officer has led the squadron with conspicuous success against enemy shipping, which, escorted by armed ships, were passing through the Straits of Dover. He has participated in every attack, and has displayed fine leadership and enterprise.

Throughout, Sqn. Ldr. Gillam has displayed great daring and he has set a magnificent example which has undoubtedly contributed materially to the notable successes achieved.

Act. Flt. Lt. R. P. STEVENS, D.F.C., R.A.F.V.R., No. 151 Squadron.—This officer has shown himself to be a fearless and outstanding night fighter pilot. One night in October, 1941, flying at sea level, he intercepted a Junkers 88 off the East Anglian coast. The raider immediately turned and flew towards the Continent at maximum speed, but Flt Lt. Stevens gave chase and slowly overhauled.

The raider then opened fire with his guns and began to drop his bombs singly. Columns of water were shot up as a result of the explosions, but Flt. Lt. Stevens swerved round them and, closing in to short range, shot down the enemy aircraft at almost sea level. He has destroyed at least 14 hostile aircraft at night.

SECOND BAR TO THE DISTINGUISHED FLYING CROSS.

Act. Flt. Lt. D. A. MCMULLEN, D.F.C., No. 266 Squadron.—This officer has participated in operational sorties over occupied France and Holland, and has always evinced the keenest desire to engage the enemy. Since being awarded a Bar to the Distinguished Flying Cross, Flt. Lt. McMullen has destroyed five hostile aircraft, bringing his total victories to at least 18, three of which were gained at night.

BAR TO THE DISTINGUISHED FLYING CROSS.

Act. Flt. Lt. E. B. MORTIMER-ROSE, D.F.C., No. 234 Squadron.—This officer is a relentless and inspiring fighter pilot. He has participated in every operational sortie undertaken by his squadron, and, many times, has carried out individual attacks in enemy occupied country with great success. Flt. Lt. Mortimer-Rose has destroyed at least seven and damaged a further nine enemy aircraft.

DISTINGUISHED FLYING CROSS.

Sqn. Ldr. G. Ft. POWELL-SHEDDON.—This officer has been engaged on operations almost since the war began. He served with a fighter squadron in the Middle East theatre of war until June, 1940, when he returned to this country and took part in the Battle of Britain. In July, 1941, Sqn. Ldr. Powell-Sheddon was posted to Malta, where he formed the night flying unit which has since performed sterling work in the night defence of Malta. By his great and energetic organising ability, together with his courage and initiative in the air, Sqn. Ldr. Powell Sheddon has contributed materially to the successes obtained. He has destroyed at least five enemy aircraft, three of which were destroyed by him during the Battle of Britain.

Act. Sqn. Ldr. P. W. LEFEVRE, No. 126 Squadron.—This officer has shown the utmost devotion to duty over a long period of operational flying, in which he has destroyed several enemy aircraft. He carried out over 250 hours' flying on convoy patrols over the North Sea, as well as participating in other operational missions. Sqn. Ldr. Lefevre has participated in operations in the Middle East, and in July, 1941, he attacked an Italian E-boat, which was forced to surrender.

Major J. F. BRITZ, S.A.A.F., No. 21 Squadron.—This officer, who displayed brilliant leadership in the East African campaign, continues to show outstanding qualities both as a pilot and flight commander, and has led several attacks on targets in the Bardia area with distinction. On one occasion when in formation with another aircraft, during a bombing attack on Bardia, both were attacked by two Messerschmitt 109s. The attackers shot down one of our aircraft, but Major Britz fearlessly closed with the enemy and shot one of them down, and, skilfully manoeuvring his aircraft, enabled his rear gunner to shoot down the other one. Throughout, this officer has displayed great courage and initiative and set an inspiring example.

Act. Flt. Lt. D. C. PASCALL, No. 38 Squadron.—This officer has completed many operational sorties, involving some several hundred hours' flying. He is an outstanding pilot, whose complete fearlessness and determination have set a fine example. One night in August, 1941, he participated in an attack on shipping in Tripoli harbour, releasing his bombs from a low height and scoring a hit on a ship which was already burning, causing another fire to break out. He also attacked other shipping outside the harbour. On another occasion when his engine failed 50 miles from his base, Flt. Lt. Pascall succeeded in making a safe landing without damaging the aircraft.

F/O. A. D. ALEXANDER, No. 108 Squadron.—This officer has been almost continually engaged on operations for the past fifteen months. He has carried out many operational missions, some of which were attacks on important targets in Germany and occupied territory. In the Middle East theatre of war he has carried out attacks against various targets, especially during the Iraq operations, with great skill and determination. Throughout F/O. Alexander has displayed high courage and

Wing Cdr. F. S. E. Stapleton, D.F.C., who was recently awarded the D.S.O. He is wearing a German life jacket which he keeps as a souvenir.

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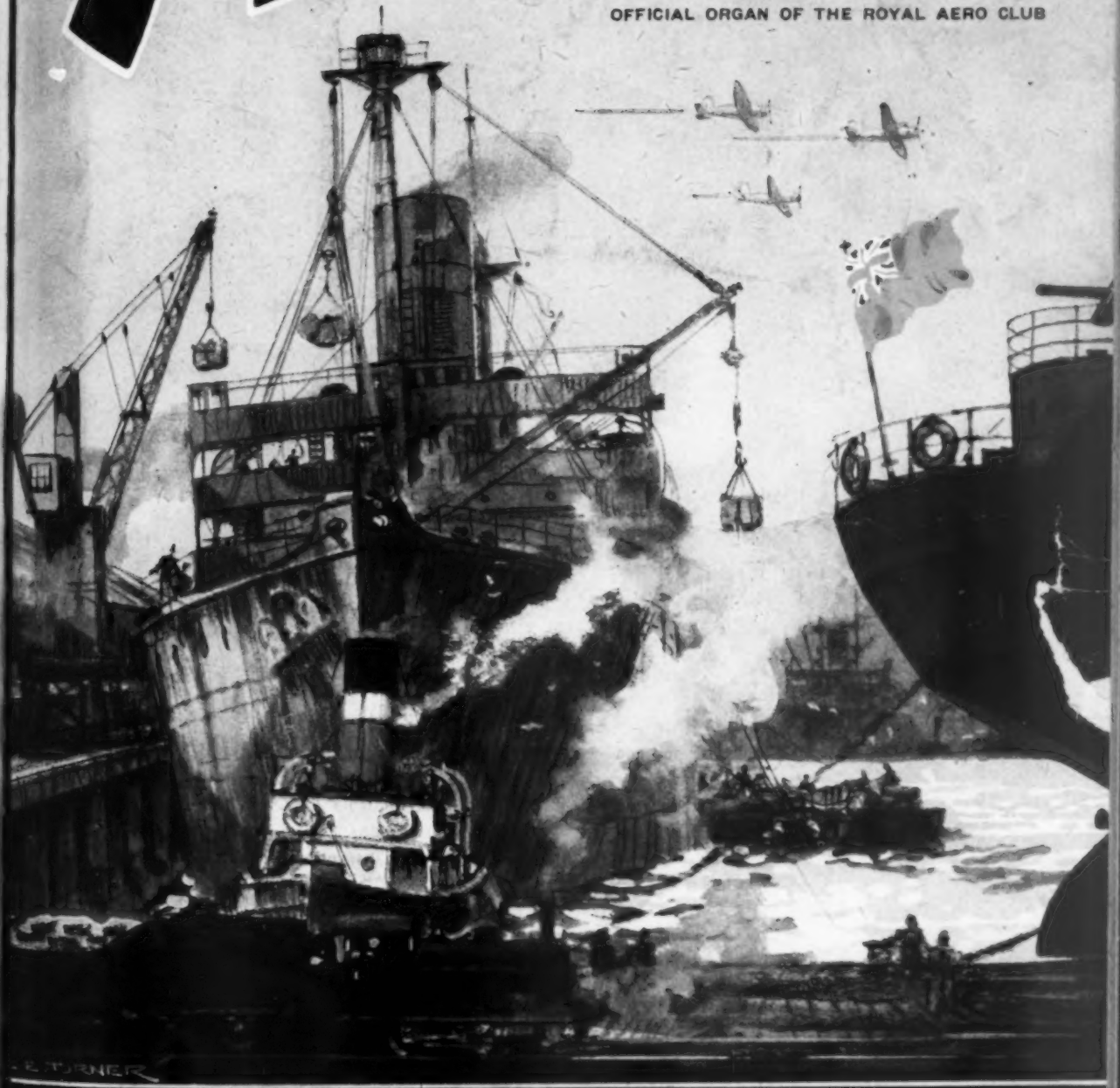

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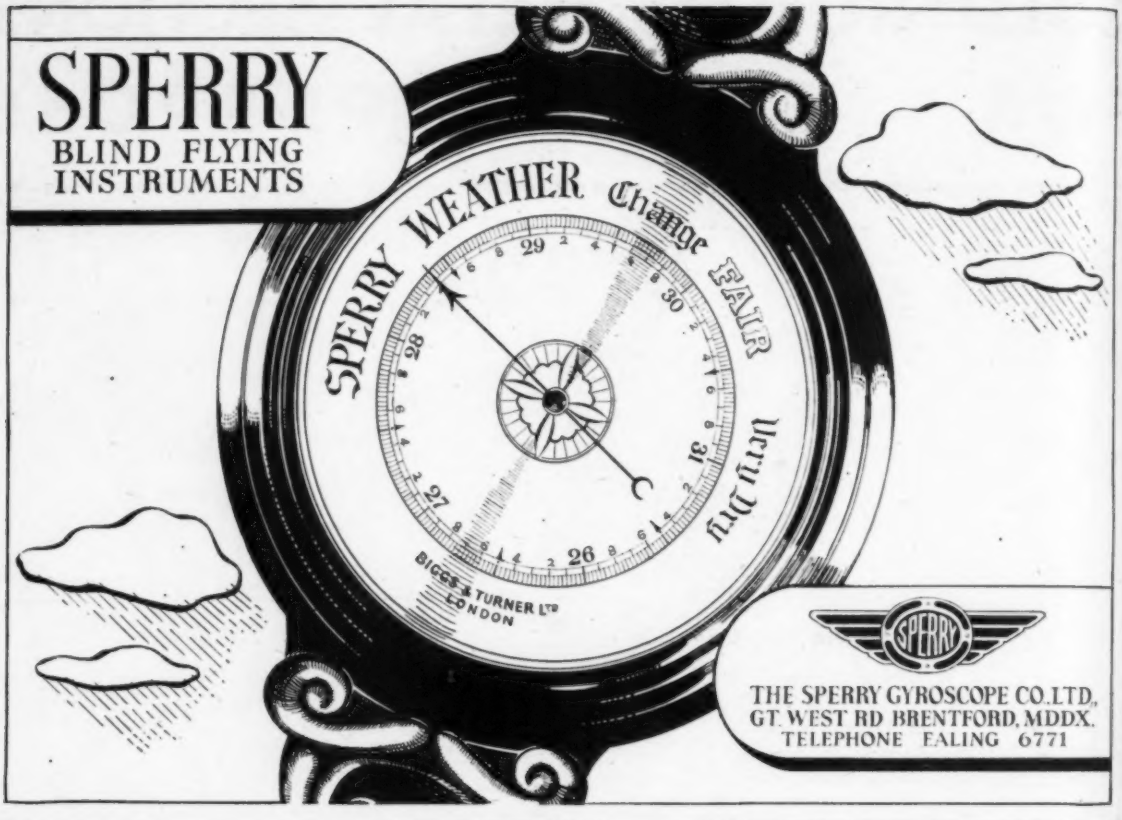

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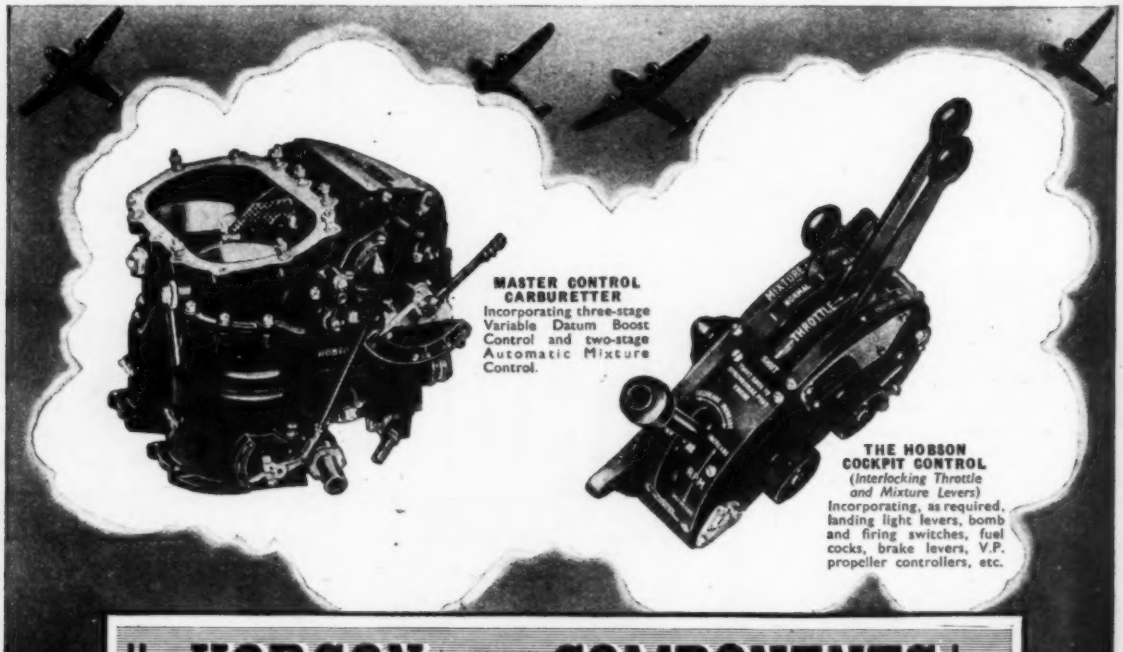

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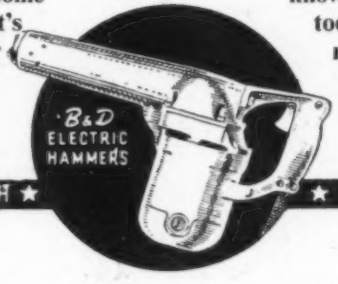

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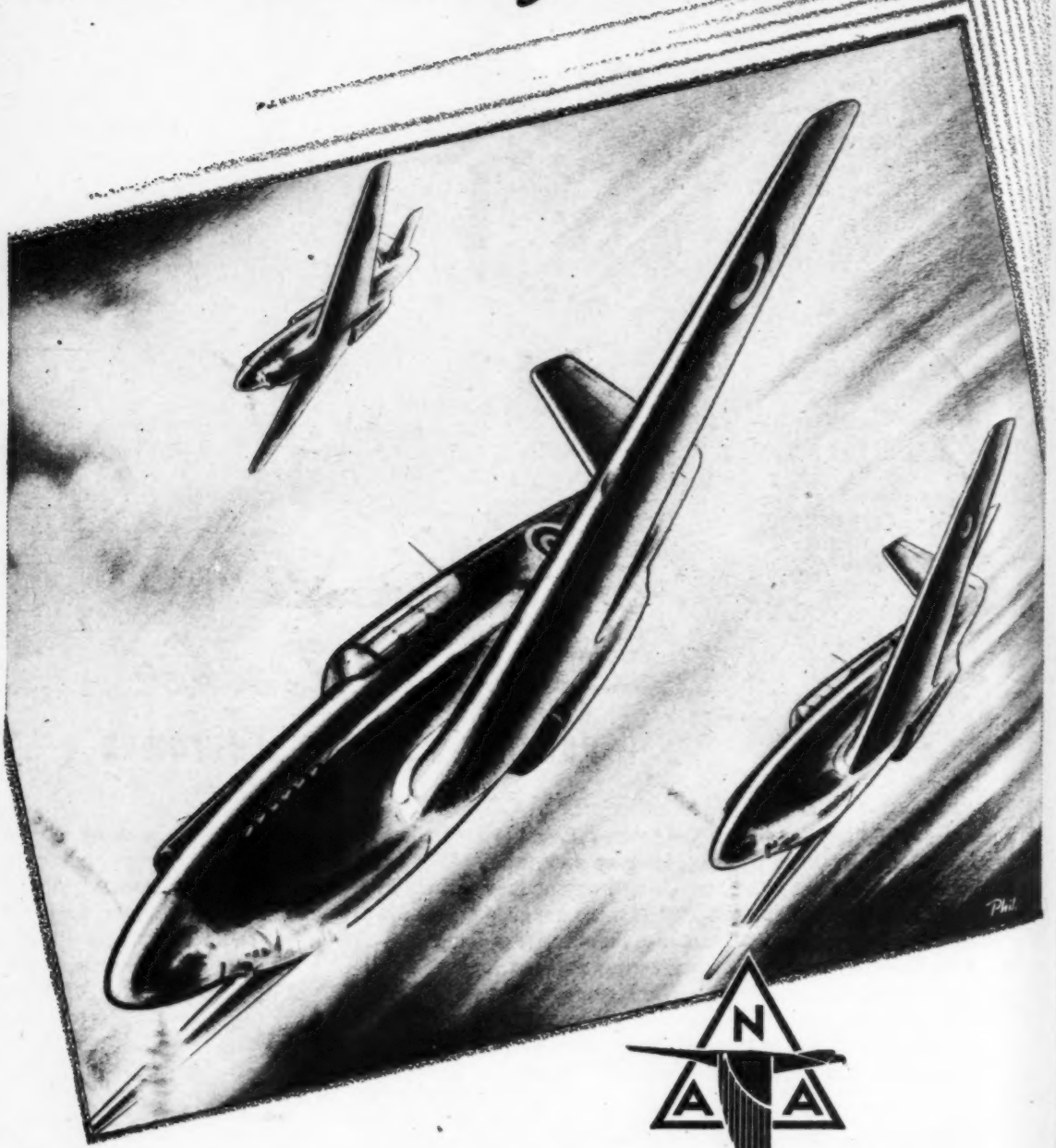

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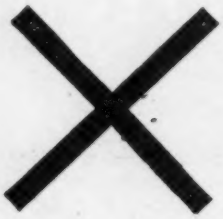

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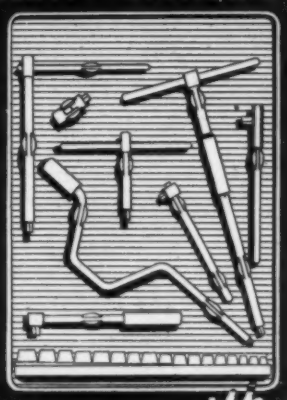

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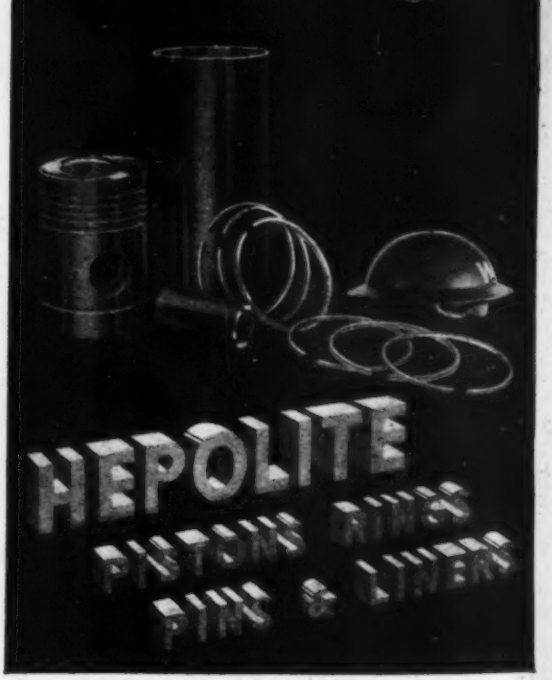

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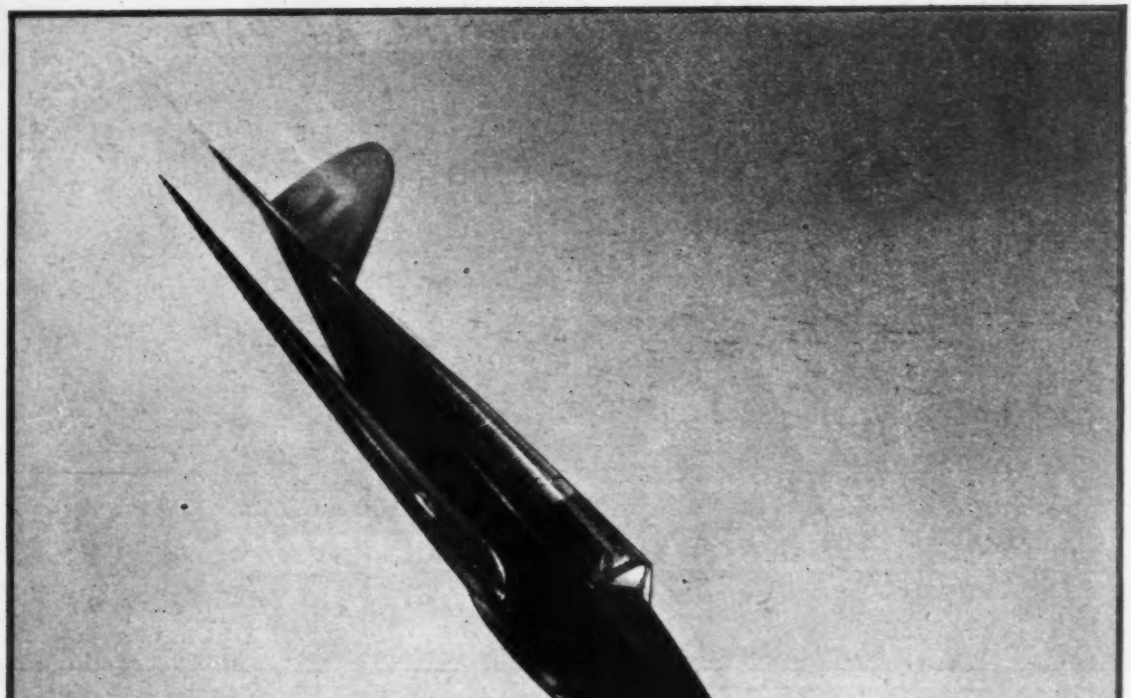

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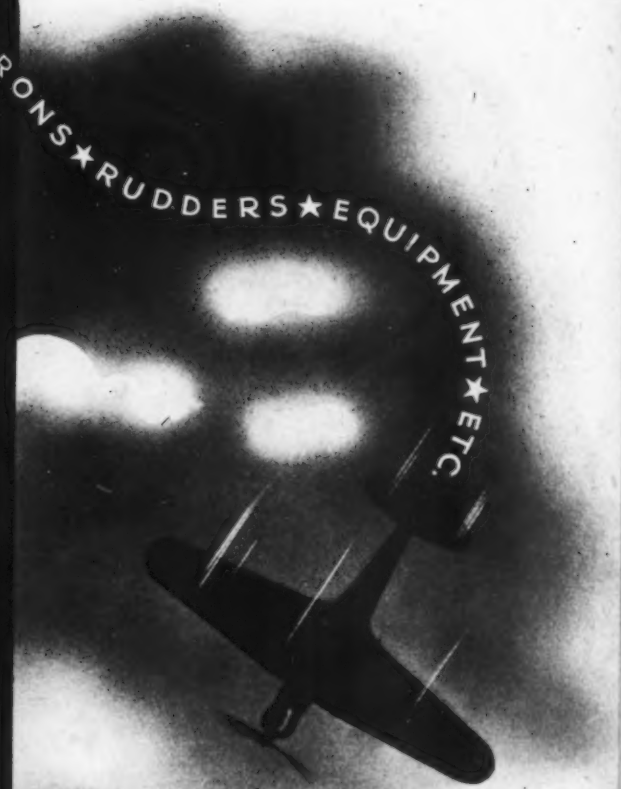

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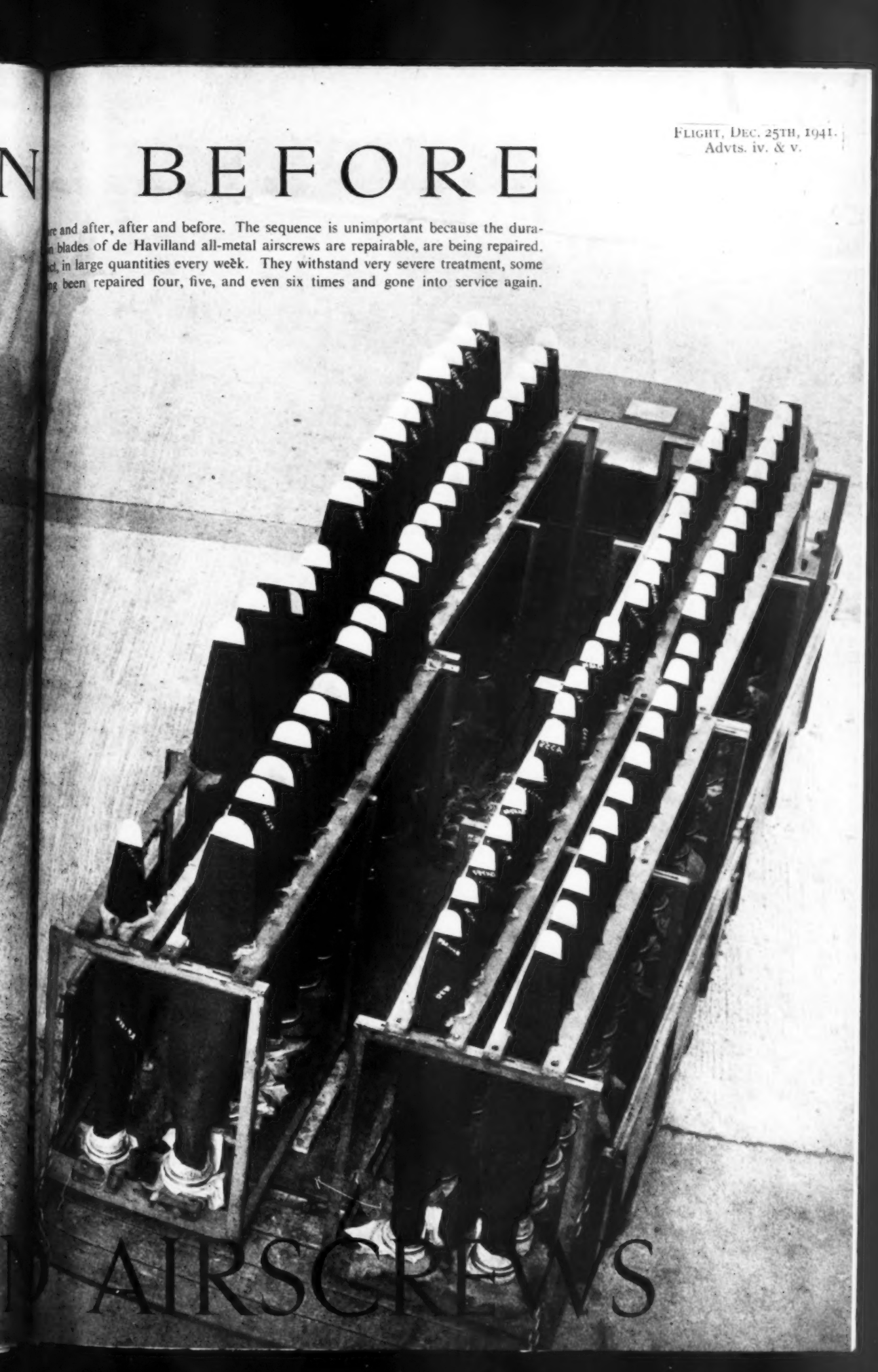

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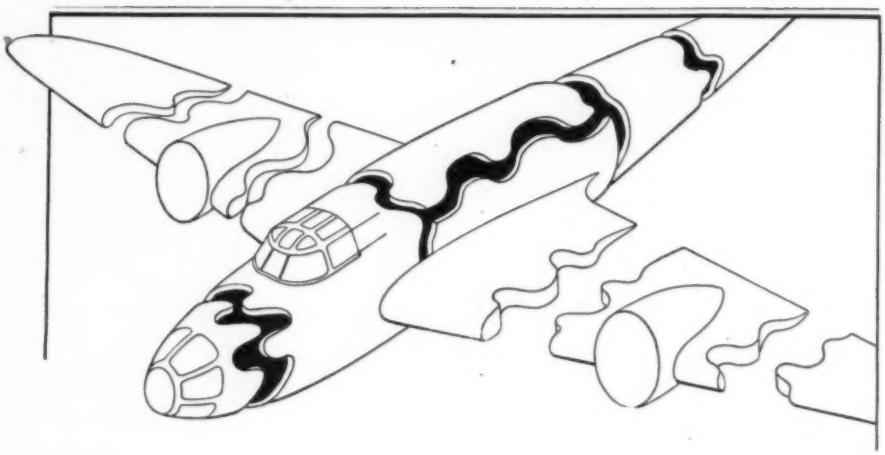

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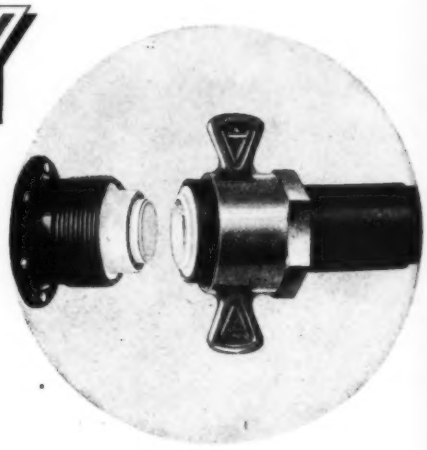

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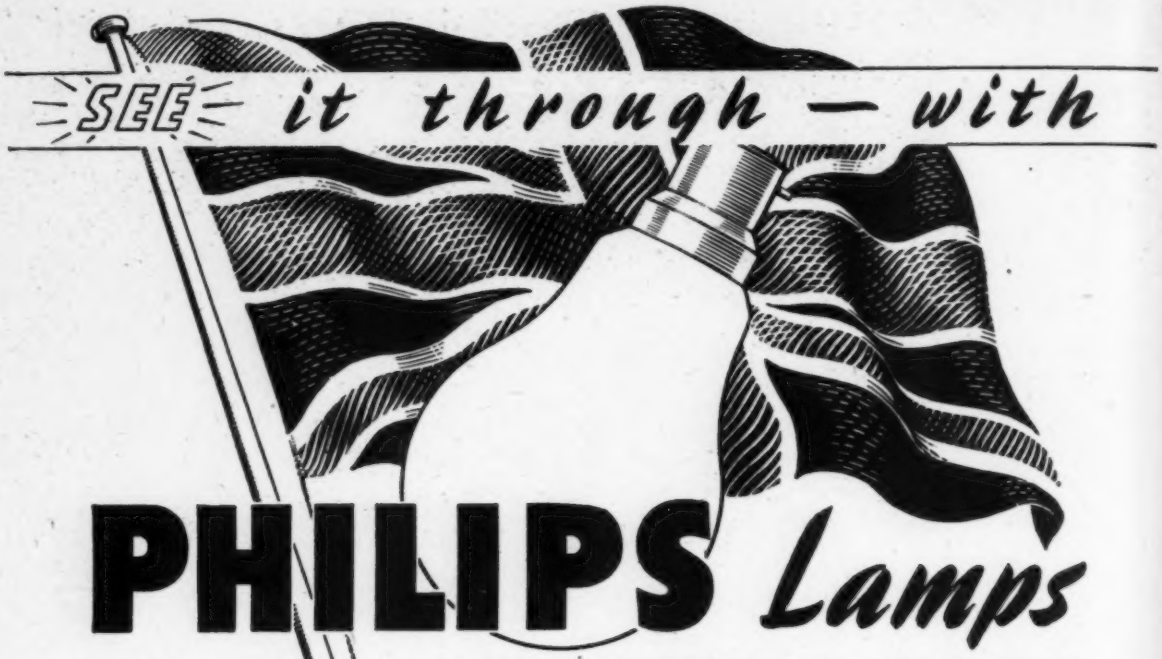

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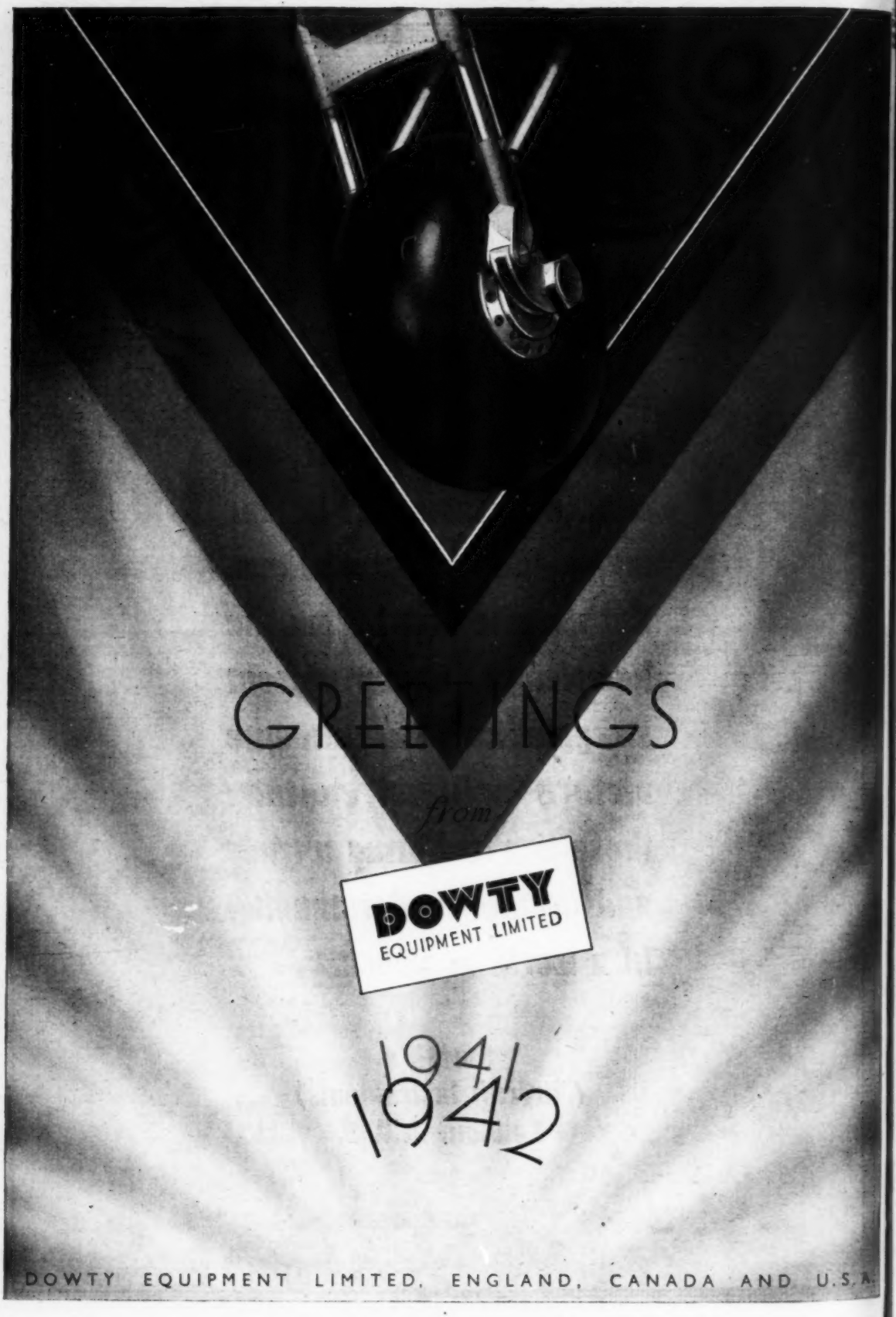
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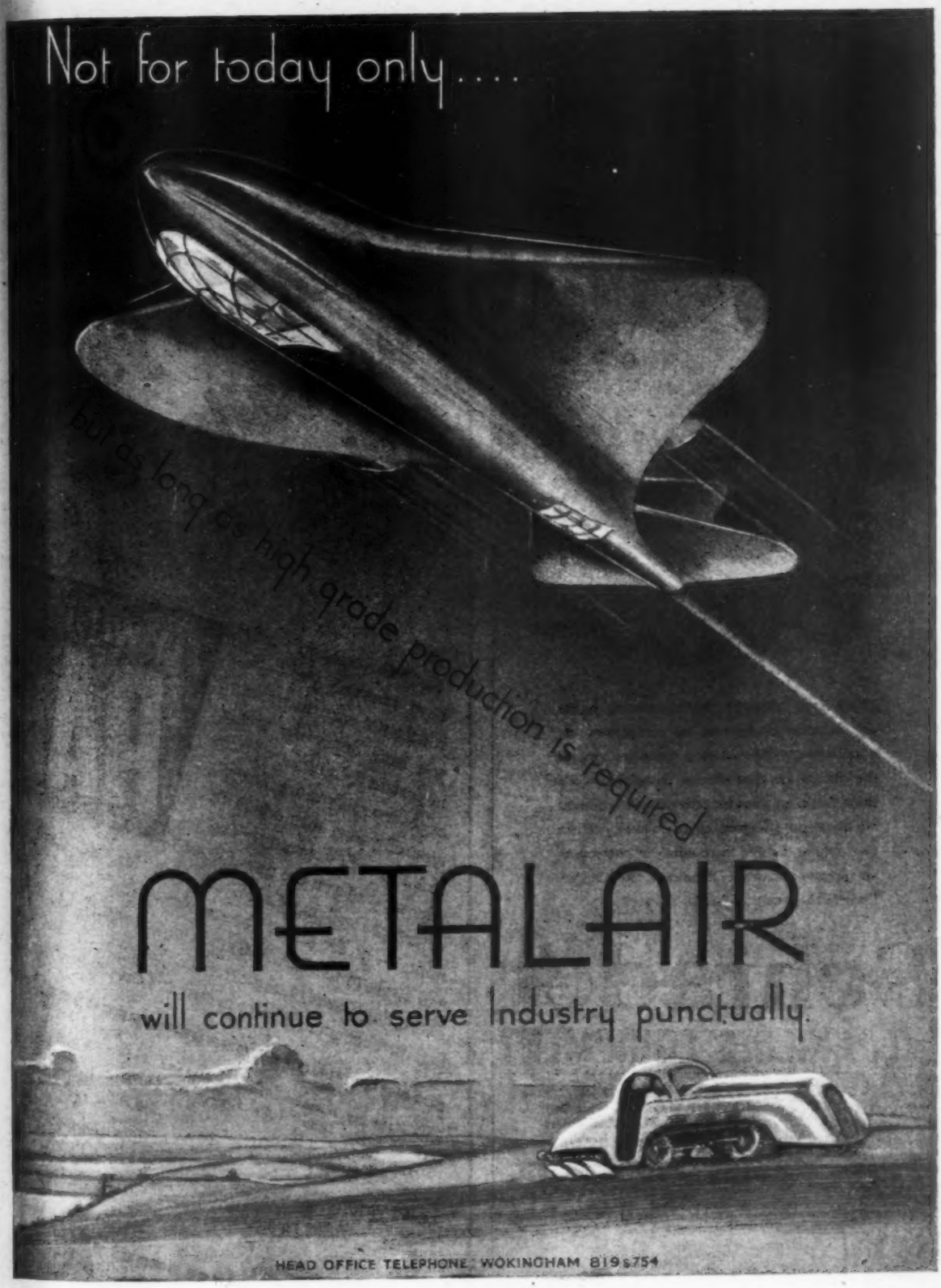
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NAME.....

ADDRESS

FLT 25/12.

SERVICE AVIATION

devotion to duty and a great enthusiasm for operations.

DISTINGUISHED FLYING MEDAL.

Sgt. A. G. BEALE, R.A.F.V.R., No. 151 Squadron.—This airman has been employed as an air gunner on operations since January, 1941, and has destroyed three and damaged several other enemy aircraft. His last success was one night in November, 1941, when he destroyed a Junkers 88. Sgt. Beale has at all times shown exceptional keenness and marked skill.

Sgt. A. T. PRINCE, No. 38 Squadron.—This airman has completed many operational sorties, involving several hundred hours' flying. He has displayed great efficiency and technical knowledge which has often contributed materially to the successes achieved. His steadiness and reliability have been most praiseworthy.

Sgt. J. B. SMITH, No. 70 Squadron.—This airman has been employed as an air observer since January, 1941, and has participated in sorties, involving hundreds of hours' flying. Throughout he has proved himself to be a highly skilled navigator and a consistently accurate bomb aimer. One day in September, 1941, his bombs totally destroyed an oil storage ship in Benghazi harbour. Later, he participated in two attacks on a newly constructed jetty in the same harbour and succeeded in obtaining five direct hits on the target. In another attack in the same area Sgt. Smith scored direct hits on a wreck which had been improvised to function as a jetty. He has also destroyed enemy oil storage tanks by extremely accurate bombing. This airman has executed much valuable work throughout.

Air Sgt. T. G. EARNSHAW, S.A.A.F., No. 21 Squadron.—This airman has participated in numerous operational sorties both in East Africa and the Western Desert. In addition to his skill as an air gunner, his work as a wireless operator has been outstanding. On one occasion, whilst flying at 25,000 feet over Bardia, he succeeded in transmitting a message of the utmost importance despite the fact that he was suffering intense pain from his frozen hands and that he was almost overcome owing to a breakdown of the oxygen supply apparatus. Two days later, he participated in a reconnaissance and, although his aircraft was subjected to intense anti-aircraft fire whilst over the target area, he succeeded in transmitting most valuable information. By his tireless self-sacrifice and initiative he has set a most praiseworthy example.

Roll of Honour

Air Ministry Casualty Communique No. 98.

THE Air Ministry regret to announce the following casualties on various dates. The next-of-kin have been informed.

Royal Air Force

KILLED IN ACTION (WHILE FLYING IN OPERATIONS AGAINST THE ENEMY).—Sgt. J. R. Mansfield; Sgt. T. L. Panting; Sgt. G. E. Sully.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. R. T. Ainsworth.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. E. P. Acton; Sgt. D. B. Beverley; Act. Wing Cdr. Birch, A.M.A.; Sgt. R. S. Browning; Sgt. W. G. Busby; Sgt. R. F. Cheesman; Sgt. E. J. Cook; P/O. H. J. Daniels; Flt. Lt. D. T. St. H. Dawes; F/O. K. P. English; Sgt. R. G. Hanson; P/O. L. B. Hewitson; Cpl. H. E. Hollis; Sgt. C. W. F. D. E. Lawson; P/O. H. M. Macrosan; Sgt. J. H. Matthews; Sgt. A. K. Mills; Sgt. H. T. W. Montgomery; Sgt. W. Puttick; Flt. Lt. B. A. Rogers; P/O. K. F. Seager; P/O. W. McN. Spiers; Act. Flt. Lt. E. N. Steel; Flt. Sgt. J. H. Tranter; Sgt. E. P. C. Vignaux; P/O. D. White; F/O. J. N. Whitney; Sgt. F. R. Worthington.

WOUNDED OR INJURED IN ACTION.—Sgt. A. Longden; Sgt. L. W. Wade.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—P/O. D. K. Hodge.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. E. R. Backhouse; Sgt. M. E. G. Hastings; P/O. A. Y. McC. McCombe; Sgt. G. Maher; Sgt. H. T. Smith.

MISSING.—Sgt. J. T. Ackroyd; P/O. V. M. Albrecht; P/O. V. D. Beaney; Sgt. G. H. S. Bennett; P/O. J. D. Berry; Sgt. R. A. Berry; Sgt. C. T. Black; Sgt. M. G. Bloomfield; P/O. P. F. J. Boreham; Sgt. G. E. Bradley; Sgt. J. C. Brooks; P/O. E. E. Brown; Sgt. R. Broxap; Sgt. W. Buchan; Sgt. S. Burgess; Sgt. J. W. Butler; Act. Flt. Lt. J. R. Campbell; Sgt. E. R. Cerely; Sgt. P. A. Champion; P/O. W. H. Cheetham; Sgt. B. Clark; Sgt. G. D. Colville; Sgt. H. A. Cook; Sgt. N. I. Cotterell; Sgt. D. C. Cranston; Sgt. M. W. Cullerne; Wing Cdr. R. S. Darbyshire; Sgt. H. R. Davies; Sgt. J. E. Davis; Sgt. R. F. Duggan; Sgt. D. C. Duguld; Sgt. K. G. Elcoate; Sgt. H. R. Elliott; P/O. L. N. Evans; Sgt. H. W. Fewkes; Flt. Sgt. J. Flannigan; Sgt. H. M. Forth; Sgt. R. L. Frank; P/O. C. G. Gilmore; Sgt. J. Glover; Flt. Sgt. A. T. Gooderham; Sgt. S. D. C. Gray; Sgt. L. C. Green; Sgt. E. I. L. Grego; P/O. W. D. C. Hardie; Sgt. A. C. F. Harrop; F/O. J. Harrop; P/O. S. Hartley; Sgt. L. G. Hillier; F/O. G. A. Hoar; P/O. A. C. L. Hodge; Sgt. J. W. Horrocks; Sgt. J. Howett; Sgt. C. C. Hynam; Sgt. J. St. G. Johnston; Sgt. P. D. King, D.F.M.; Sgt. A. G. Kinnear; Sgt. F. R. Lamin; Sgt. J. H. Langley; F/O. R. A. Lenton; Sgt. E. Leverington; P/O. A. E. Lloyd; Sgt. W. J. Macconnachie; Sgt. S. R. Mandall; Sgn. Ldr. J. Mercer; Sgt. T. G. Miskin; P/O E. G. Mounsey; Sgt. J. Mycock; Sgt. W. Partington; P/O. H. L. Powell; Sgt. W. Powell; Sgt. F. G. Rae; Sgt. H. E. Roberts; Sgt. T. W. Robson; Sgt. F. H. Sanders; Sgt. L. E. Scantlebury; Sgt. E. R. Schofield; Sgt. P. S. Simpson; P/O. W. J. Sipprell; Act. Flt. Lt. J. E. Slade; Sgt. D. F. Spindler; Sgt. K. D. Spry; Sgt. J. D. Thompson; Sgt. S. J. Thorogood; Sgt. R. B. Turner; P/O. H. Walter; Sgt. A. E. Ward; Sgt. J. H. Watson; Sgt. W. Watson, 612507; Sgt. W. Watson, 755474; Sgt. R. F. Whitton; Sgt. G. W. T. Wiggs; Sgt. G. O. Williams; F/O. H. E. P. Williams; Sgt. C. E. Wood; Sgt. T. P. Woodhouse; Sgt. B. J. Wrampling; Flt. Sgt. V. G. Wright.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE DUTIES OR ON THE GROUND THROUGH ENEMY (WHILE ENGAGED ON NON-OPERATIONAL FLYING ACTION).—L.A/C. (Cadet) T. X. Bradbury; Act. F/O. N. Cox; A/C.1 K. R. E. Dutton; Sgt. D. J. Parr; Sgt. L. G. Staniland; A/C.2 I. Tankel; A/C.2 E. Wilson.

KILLED ON ACTIVE SERVICE.—P/O. H. R. Baker; Sgt. J. M. Butterworth; L.A/C. R. H. Carey; L.A/C. A. G. Clayden; Sgt. A. R. Enderby; Sgt. W. J. Huth; Cpl. J. Laxton; L.A/C. F. A. Lee Norman; Flt. Sgt. J. A. Rich; P/O. H. Rose; A/C.2 E. C. Ryall; Sgt. O. J. Simmonds; P/O. R. C. Symes; Sgt. V. A. Taylor; Sgt. F. H. P. Tolley; Flt. Sgt. W. Walker; Sgt. D. Winstanley.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. G. E. Cook; Sgt. P. J. Cross; Sgt. C. W. Kerridge.

WOUNDED OR INJURED ON ACTIVE SERVICE.—L.A/C. K. S. Archibald; Sgt. E. W. Bignell; L.A/C. J. M. Jones; P/O. W. V. Peet; P/O. J. N. Sanders; Sgt. J. R. Smith; Sgt. C. R. Whitworth.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—P/O. R. R. Clamp; P/O. J. H. Jolliffe; L.A/C. P. McCallum.

DIED ON ACTIVE SERVICE.—A/C.2 E. J. Baldry; A/C.2 C. R. Chappell; A/C.1 H. Darbyshire; A/C.2 R. W. Holt; Cpl. A. J. Regan; A/C.1 D. Tudor.

Royal Australian Air Force

WOUNDED OR INJURED IN ACTION.—F/O. H. W. Foster.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. D. Macdonald.

MISSING.—Sgt. W. Bourke; Sgt. J. E. L. Clark; Sgt. B. M. Geissmann; Sgt. C. A. Guan; Sgt. L. J. Hanley; Sgt. T. A. H. Hiddleston; Sgt. I. R. McCalman.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—Sgt. M. J. Bell.

KILLED ON ACTIVE SERVICE.—P/O. T. N. D. Boyd; P/O. R. M. Cooke; Sgt. L. G. Horsfall; Sgt. A. G. Shea; Sgt. T. G. Williams.

Royal Canadian Air Force

WOUNDED OR INJURED IN ACTION.—Sgt. J. E. Williams.

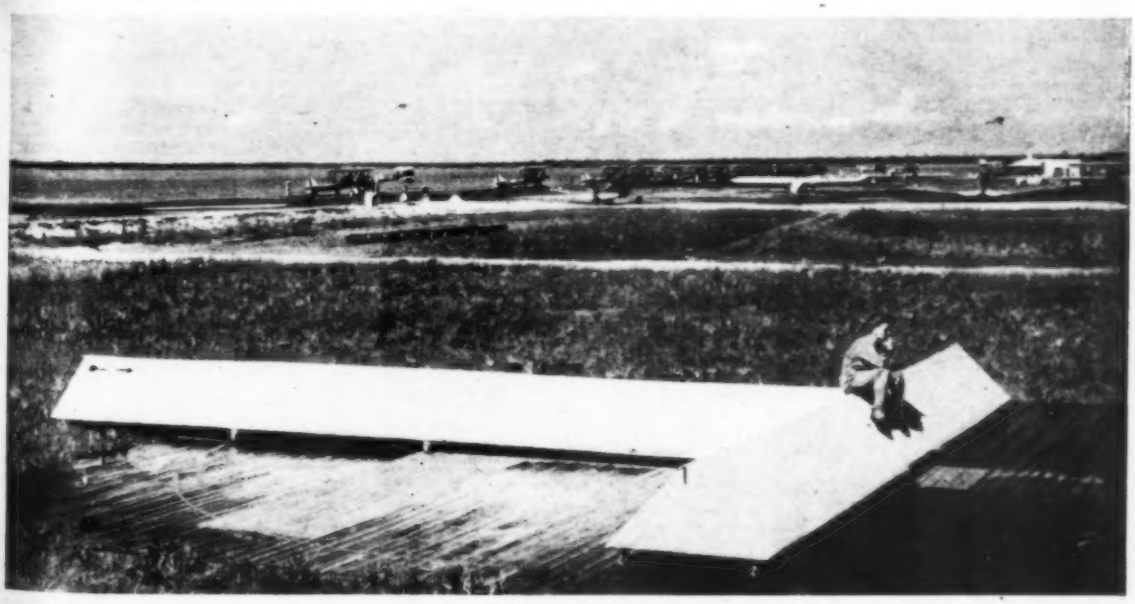
DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—P/O. D. M. Waldon.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. F. R. Humphries.

MISSING.—Sgt. C. H. Bell; Sgt. J. M. Boyd; Sgt. A. T. Bradly; Sgt. F. C. Brooke; Sgt. F. L. Capstick; Sgt. K. C. Carr; Sgt. F. J. Cunliffe; Sgt. C. C. Gardner; Sgt. A. L. D. Hasan; Sgt. J. R. Johnson; Sgt. F. M. Legere; P/O. K. B. McGoun; Sgt. G. A. McLeod; Sgt. B. C. Macnab; P/O. A. L. Miller; Sgt. C. S. O'Brien; Sgt. W. F. Sellars; Act. F/O. E. L. Shea; P/O. M. K. Solheim; Sgt. J. H. Stoll.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—Sgt. D. Chapman; Sgt. J. R. Sullivan.

KILLED ON ACTIVE SERVICE.—Sgt. S. J. Connell; Sgt. J. F. Duggan; Sgt. A. G. Dumville; P/O.



At one of the air training schools in America where delinquents are made to sit on the landing tee until they are superseded by the next customer.

SERVICE AVIATION

M. F. Gibson; Sgt. R. C. Hollingworth; Sgt. P. E. Lacey.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Sgt. D. A. Mitchell.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. D. G. Anderson; Sgt. D. A. E. Bremner; Sgt. G. Maclusky.

Royal New Zealand Air Force

KILLED IN ACTION.—Sgt. C. A. G. Dale; Sgt. F. M. McCaffrey.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. S. H. Macdonald.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. N. E. Thomson.

WOUNDED OR INJURED IN ACTION.—Sgt. I. J. McNeil.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—P/O. D. T. Herrick.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. J. C. McK. Gibson.

MISSING.—Sgt. J. W. Black; Sgt. T. H. Gray; Sgt. A. T. Hall; Sgt. G. I. Harrowby; P/O. E. Lloyd; P/O. N. F. McLean.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Sgt. F. S. Kirke.

South African Air Force

MISSING.—2/Lt. N. C. Blake; Air Sgt. L. R. G. Brand; Air Sgt. P. H. Clarence; 2/Lt. F. R. Meinjies; Air Sgt. P. L. E. Methven; 2/Lt. J. H. Meyer; Capt. G. W. Parsons; Air Sgt. L. P. Stewart.

Casualty Communique, No. 99.

THE Air Ministry regret to announce the following casualties on various dates. The next-of-kin have been informed.

Royal Air Force

KILLED IN ACTION (WHILE FLYING IN OPERATIONS AGAINST THE ENEMY).—P/O. R. E. Hutchin; F/O. M. E. Staples.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. G. Allanson; P/O. K. Ballas-Anderson; Sgt. G. C. Bennett; Act. Wing Cdr. I. W. Braye, D.F.C.; P/O. W. Brown; Sgt. E. P. Collingborn; Flt. Sgt. P. Conlon; Sgt. A. J. M. David; Sgt. A. C. Evans; F/O. M. H. Franklin; Sgt. D. G. Garn; Act. Sqn. Ldr. D. C. F. Good, D.F.C.; Sgt. J. Hickinbotham; Sgt. E. J. Holman; Sgt. G. H. Howard; Sgt. C. Hutchinson; Sgt. J. Hutchison; Sgt. P. S. Huxstep; Sgt. E. S. Jones; Sgt. E. Keetley; Sgt. P. R. Lanchbery; Sgt. G. E. Lang; P/O. P. McMillan; Sgt. H. C. Page; Sgt. K. C. Peek; Wing Cdr. P. J. Polglase; Sgt. D. A. Rawlings; Sgt. A. Robertson; P/O. D. A. Rogers; Sgt. R. E. Rowley; Sgt. F. C. Sloane; Sgt. V. J. Stickland; Sgt. D. W. Townsend; P/O. J. G. E. Willis.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—P/O. H. Batzofin.

W.A.A.F. Flight Mechanics at work on a Hurricane at a training centre. These girls will soon be posted to squadrons.

Chinese flying cadets who are undergoing 20 weeks' training at Thunderbird Field, Arizona.

WOUNDED OR INJURED IN ACTION.—Flt. Sgt N. E. Bohn; Sgt. H. Lord; F/O. E. S. S. Nash.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. T. R. Buckley; Sgt. A. C. Edwards; Sgt. R. E. French; Sgt. J. Gibson; Sgt. I. Hamilton; Sgt. L. Lawson; Sgt. D. E. Mills; Sgt. G. Robinson; Sgt. E. J. Sargent; Sgt. A. Stringer.

MISSING.—Sgt. R. L. Armsby; Sgt. J. H. Atkin; Act. F/O. S. Austin, D.F.M.; Sgt. G. L. Bailey; F/O. G. G. Bailey; Sgt. A. McK. Barr; P/O. W. G. C. Beatson; F/O. G. C. H. Birchall; P/O. N. E. Bishop; Sgt. N. Bradley; P/O. D. E. W. Brown; Act. Flt. Lt. D. A. Buchan; P/O. A. Carey-Hill; Sgt. T. Copsey; P/O. J. P. Croker; Sgt. S. W. Dane; Sgt. A. F. Daniels; Sgt. A. C. A. Davis; Sgt. R. Dean; Sgt. A. R. A. Dexter; Sgt. E. W. Elkington; Sgt. N. Fenton; Sgt. E. Fieldhouse; P/O. W. J. Frost; Sgt. E. F. Gresham; Sgt. K. Harwood-Smith; Sgt. W. H. Jeffries; Sgt. M. A. Jenkins; P/O. H. Jones; Sgt. P. I. Leeman; Sgt. W. C. Lees; P/O. J. Lindsay; Sgt. P. N. Lloyd; Sgt. G. A. McGarvey; Sgt. A. MacKenzie; Sgt. E. A. Main; Sgt. F. W. Manners; Sgt. D. V. Marhall; Sgt. B. J. Monk; Sgt. K. Morris; Sgt. D. F. W. Norton; Sgt. J. C. Pengelly; P/O. G. H. J. Pickering; Flt. Lt. C. P. D. Price, D.F.C.; Sgt. D. R. Pritchard; Sgt. D. R. Rawlings; Sgt. I. J. Robertson; Sgt. D. Rowley-Blake; P/O. R. B. P. Roy; Sgt. J. Samsome; Wing Cdr. A. T. D. Sanders, D.F.C.; Sgt. W. E. Sapsed; Sgt. A. Scott; P/O. F. L. Smith; Flt. Sgt. C. Stanley, D.F.M.; Sgt. P. H. Stanton; Sgt. E. R. Thomas; Sgt. P. G. Thompson; Sgt. R. F. Thompson; Sgt. S. Thomson; P/O. K. M. Tuckfield; Sgt. H. Vickers; Sgt. R. Wade; P/O. G. Whitaker; Sgt. G. E. Williamson.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE (WHILE ENGAGED ON NON-OPERATIONAL FLYING DUTIES OR ON THE GROUND THROUGH ENEMY ACTION).—Flt. Sgt. J. Carr; Flt. Sgt. G. A. Dodds.

KILLED ON ACTIVE SERVICE.—Flt. Lt. S. Baker; P/O. B. Bowers; Sgt K. Bryant; Act. F/O. E. M. Cowperthwaite; P/O. O. Davidson; Sgt. B. E. Dew; L.A/C. R. H. W. Dix; Sgt. G. D. H. Dutton; L.A/C. D. T. Foulger; A/C.2 W. H. Fulcher; L.A/C. E. N. G. N. Furze; P/O. H. L. Hewlitt; Sgt. W. Holden; Sgt. N. L. Hornsey; P/O C. E. Horwood; Sgt. E. R. Jessop; L.A/C. R. Kennet-Dawson; Sgt. R. C. Knott; L.A/C. R. Marshall; Act. Sqn. Ldr. S. T. Mearcs, D.F.C.; F/O. H. S. Mellows; L.A/C. R. Muir; Sgt. R. O. Newbury; F/O. D. H. Nock; Sgt. F. M. Oddy; L.A/C. C. C. Paterson; Sgt. H. D. Perrin; L.A/C. D. C. Ross; P/O. J. R. Sale; L.A/C W. J. V. Samuel; P/O. R. O. Scarborough; L.A/C. A. J. Searle; Act. F/O. L. Stokes; L.A/C. F. Watkins; Flt. Lt. D. E. Waymark; Flt. Lt. A. P. S. Wills; Sgt. M. T. G. Willson; A/C.2 A. G. Wilson.

PREVIOUSLY REPORTED MISSING BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—A/C.1 W. T. Guilfoyle; Sgt. M. Ward.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Sgt. G. R. Adler; P/O. N. P. W. Conquer; Sgt. F. W. S. Cross; Sgt. J. H. Gray; L.A/C. J. Greenwood; L.A/C. F. G. A. Reynolds; Sgt. A. Roffe; L.A/C. J. R. Whittaker.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. C. C. Crozier.

DIED ON ACTIVE SERVICE.—A/C.1 W. L. Atter; F/O. C. C. O. Bermingham; Sgt. A. Davis; A/C.2 W. Dean; A/C.2 H. F. East; A/C.2 W. J. Elliott; Act. Sgt. S. Ferguson; Cpl. J. H. Fountain; A/C.1 S. Gawthroup; L.A/C. H. George; A/C.1 D. P. V. Gibb; L.A/C. A. McD. Graham; A/C.2 J. A. Harding; L.A/C. R. W. Horsfield; L.A/C. A. E. Horton; Sgt. B. Ineson; A/C.2 H. J. James; A/C.1 G. Jeavons; L.A/C. F. M. Johnson; Cpl. H. Knott; L.A/C. A. L. Langley; Cpl. S. P. McAllister; A/C.1 R. A. MacQueen; A/C.2 F. G. Malin; A/C.1 W. J. O. Matthews; A/C.1 H. A. Penfold; Flt. Sgt. A. T. Percival; Cpl. T. Porter; A/C.1 G. Roberts; A/C.2 N. C. Rutherford; L.A/C. T. Selwood; F/O. A. W. Stevens; Cpl. A. D. Stokes; A/C.2 E. Taylor; L.A/C. D. W. F. Wedderburn; A/C.2 H. E. Wheeler; L.A/C. A. L. Williams; A/C.2 P. H. Williams; A/C.1 E. H. Winnard; A/C.2 R. Wood.

PREVIOUSLY REPORTED MISSING, NOW REPORTED SAFE.—Sgt. A. G. Mee; Sgt. J. Miller.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Sgt. R. C. Thompson; A/C.1 A. Zelbard.

Royal Australian Air Force

KILLED IN ACTION.—Sgt. I. H. Stirrat.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—L.A/C R. D. Bell; Cpt. F. Hewitt.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. R. F. Curlewis; Sgt. W. A. Hopkinson

MISSING.—Sgt. A. W. Chapman; P/O. J. Macdonald; Sgt G. Painter; Sgt. J. Pender; Sgt. N. J. Weston.

KILLED ON ACTIVE SERVICE.—Sgt. R. W. Durdin; Sgt. H. C. Howard.

DIED ON ACTIVE SERVICE.—L.A/C. F. W. Bidgood.

Royal Canadian Air Force

KILLED IN ACTION.—P/O. J. A. Watson.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. G. B. Smith.

MISSING, BELIEVED KILLED IN ACTION.—Flt. Lt. G. C. Pryor; Sgt. J. D. Woodburn, D.F.M.

MISSING.—Sgt. J. Bradshaw; Sgt. C. R. Bronson; P/O. W. R. J. Brown; Sgt. G. N. Bryan; Flt. Lt. C. Bushell; P/O. J. F. Codville; Sgt. H. R. Crowe; Sgt. F. J. Hazlett; Sgt. F. T. James; Sgt. W. R. Lance; P/O. C. T. Lane; Sgt. G. A. Lowe; F/O. H. W. Oldham; Sgt. J. G. Smith; Sgt. H. F. Stentiford; F/O. C. A. B. Wallace; P/O. J. C. Wilson; Sgt. G. Yeates.

KILLED ON ACTIVE SERVICE.—Sgt. W. L. Fraser; Sgt. L. H. Pitt.

Royal New Zealand Air Force

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Flt. Lt. N. Williams, D.F.C.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. T. R. Murphy.

MISSING.—Sgt. H. McL. Macdonald; Sgt. J. S. Parry; Sgt. E. B te M. Robertson; P/O. L. W. Stevenson.

KILLED ON ACTIVE SERVICE.—Sgt. K. C. Phillips.

South African Air Force

KILLED IN ACTION.—2/Lt. A. W. Alder.

WOUNDED OR INJURED IN ACTION.—Air Sgt. N. T. Langton.

MISSING.—2/Lt. J. N. Murphy.

KILLED ON ACTIVE SERVICE.—2/Lt. E. B. Smyth.

Indian Air Force

KILLED ON ACTIVE SERVICE.—P/O. H. C. Mehta.

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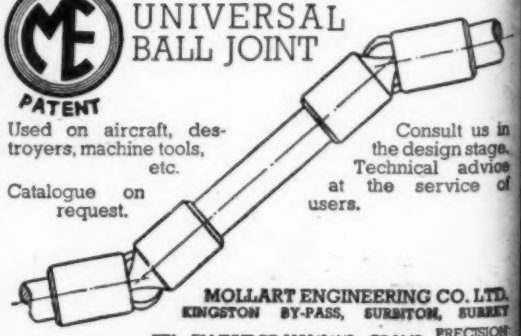

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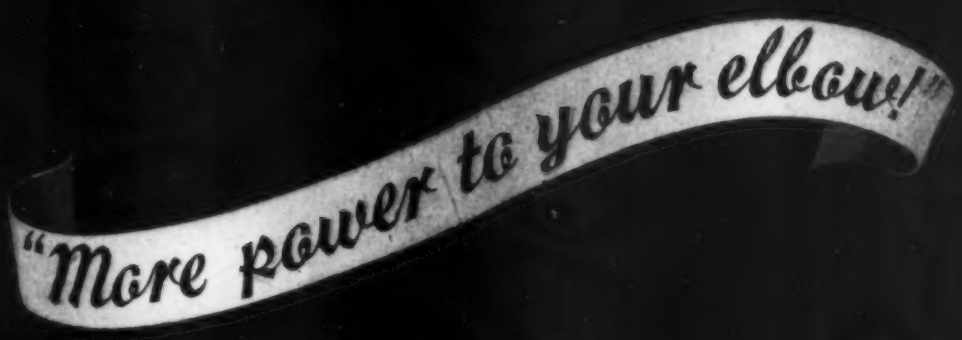
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